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13. ABSTRACT (Maximum 200 words) A growing form of interaction between organizational information systems is the use of Electronic Data Interchange (EDI). Conceptually, the scope of EDI could be extended beyond transmitting business documents between customers and suppliers. Specifically, it should be possible through a fully integrated EDI/CIM system to enable a customer to interact with their suppliers using structured messages, requesting information about the quality assurance test results of the products at the supplier's manufacturing plant in a timely manner. Trading Partner PC version 4.40 software from TSI International was purchased and installed at the CRAMTD Demonstration Site. Key business transactions requiring the support of the plant Oracle database were identified and scripts written to integrate these EDI transactions with the database. It is recommended that EDI be continued as an aspect of the Demonstration Site and that in concert with DPSC Procurement activities, the Demonstration Site also undertake a proactive role in supporting Combat Ration Producers becoming Trading Partners to DPSC.				
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Contents

1.0 CRAMTD STP #22	1
1.1 Introduction and Background	1
1.2 Results and Conclusions	2
1.3 Recommendations	2
2.0 Program Management	3
2.1 Summary of STP Accomplishments	3
3.0 Short Term Project Activities	4
3.1 STP Phase I Tasks	4
3.1.1 Current Business Practices (Task 3.3.1.1)	4
3.1.2 Existing EDI Hardware/Software (3.3.1.2)	4
3.2 STP Phase II Tasks	4
3.2.1 Acquire Hardware/Software (3.3.2.1)	4
3.2.2 CIM Integration (3.3.2.2)	8
3.3 STP Phase III Tasks	9
3.3.1 Demonstrate EDI/CIM (3.3.3.1)	9
3.3.2 Identify Technology Transfer Partners (3.3.3.2)	10
3.3.3 Provide Technical Guidance (3.3.3.3)	10
4.0 Appendix	11
4.1 Figure 1 CRAMTD STP #22 Time and Events Milestones	
4.2 Technical Working Paper (TWP) 95, "Electronic Data Interchange: Introduction, Concepts and Examples"	
4.3 Technical Working Paper (TWP) 98, "Electronic Data Interchange: EDI Translation Software Evaluation"	

1.0 CRAMTD STP #22

Results and Accomplishments

1.1 Introduction and Background

STP#22 started May 1, 1994 based on technical and cost proposals dated April 20, 1994 that were submitted to the DLA on April 22, 1994 and ended July 29, 1995. Final approval for the project was received on May 26, 1994. The broad objective of the project was to develop an Electronic Data Interchange (EDI) informational model that could serve as a practical tool for engineering and system design and for management decision making.

A growing form of interaction between organizational information systems is the use of paperless information through EDI. The implementation of EDI began in the early 1980's and has reached a point where large and medium-size companies demand that their suppliers use EDI. Hence, by adopting EDI companies will have a competitive advantage.

For an EDI system to be effective, the trading partners' internal information systems must contain three fundamental components: a communication network, translation software that converts the internal data format to the message standard and vice versa, and the application which is the business function where information is generated/needed, e.g., purchasing, material management, quality management. It is important to ensure the proper integration of an EDI system with the enterprise's application.

Typically, EDI has been used to transmit business documents such as bids, invoices and orders between a customer and suppliers, thus avoiding paperwork and repeated data entry.

Conceptually, the scope of EDI could be extended beyond transmitting business documents between customers and suppliers. Specifically, it should be possible through a fully integrated EDI/CIM system to enable a customer to interact with their suppliers using structured messages, requesting information about the quality assurance test results of the products at the supplier's manufacturing plant in a timely manner. As a result of such access, the customer is aware of the quality aspects of the product before it is shipped from the supplier's plant. The customer would be assured of the shipment of those products that meet his quality standards.

With the capability of a fully integrated EDI/CIM system, producers now limited to Government products may be convinced to compete, and thus insuring their survival, in civilian markets where many large companies are urging and in some cases demanding that suppliers use EDI. Further, civilian producers who already use EDI could be shown how to interface with Government EDI systems, hence being able to broaden their customer base.

The product of this Project was to be a useful and accurate model of the flow of EDI data in an interactive production environment, which is an essential part of a Computer Integrated Manufacturing (CIM) system. Such a model would be invaluable in the development, testing and evaluation of strategies and control schemes for the automated handling of products in the

system. Application areas span a wide variety of industries, from those using traditional management systems, to those employing the more exotic high-tech systems.

1.2 Results and Conclusions

Following a review of current EDI practices and the availability of EDI hardware and software, evaluation techniques and criteria were defined to assist selection of EDI translation software to meet the particular needs of a potential trading partner.

Trading Partner PC version 4.40 software from TSI International was purchased and installed at the CRAMTD Demonstration Site. Key business transactions requiring the support of the plant Oracle database were identified and scripts written to integrate these EDI transactions with the database.

An EDI trading partner relationship could not be established with DPSC Subsistence during the time of the STP. Since the software remains installed at the Demonstration Site, such Interchange should be established at such time as both "trading partners" are technically ready and then retained as a demonstration for the Combat Ration industry.

A ground-breaking aspect of this STP, incorporation of product quality data into the EDI transaction set, was not accomplished. The pilot effort at the National Institute of Science and Technology (NIST) which was to include product description in future EDI transactions did not reach the stage where CRAMTD EDI participation was possible.

1.3 Recommendations

It is recommended that EDI be continued as an aspect of the Food Manufacturing Technology Facility (Demonstration Site) and that opportunities be sought with DPSC, NIST and commercial entities to establish a demonstration EDI trading partner relationship. At such time as active Trading Partner relationships are closer to being established in Operational Rations, the CAFT Food Manufacturing Technology Facility (Demonstration Site) can provide workshops. In concert with DPSC Procurement activities, the Demonstration Site under CORANET DEMO and a CORANET Short Term Project can also undertake a proactive role in supporting Combat Ration Producers becoming Trading Partners to DPSC.

Transmittal of product quality data is included in the objectives of the "Vendor Evaluation System" (see Final Technical Report FTR 20.0, "Vendor Evaluation System", STP #60. Available from The Center for Advanced Food Technology, 120 New England Avenue, Piscataway, NJ 08854, Phone (908) 445-6130, FAX (908) 445-6145). EDI transactions consistent with ANSI X.12 standards may be the best format for commercial applications. Accordingly, EDI technology would be appropriate to include in the final DPSC vendor quality data acquisition system. A relationship with NIST to "standardize" product quality data should continue. In any event, establishing a capability for such transfers should maximize compatibility between hardware and software requirements.

2.0 Program Management

STP #22 was a three-phase work activity. The three phases had the following general objectives:

- Phase I** Analyze current business practices and review existing EDI hardware, software and protocols, selecting that suitable for the proposed EDI/CIM implementation.
- Phase II** Acquire necessary hardware and software, install in the CRAMTD site, define required modifications to effect CIM integration and develop such modifications as are consistent with the time/resource scope of the project.
- Phase III** Demonstrate the functional EDI/CIM system in the CRAMTD.

A limited version of a selected EDI system is to be installed and tested from the perspective of a combat ration producer, investigating the need for customization of the selected EDI in order to merge that system with internal systems (CIM) to achieve an integrated enterprise management system. An evaluation procedure will be developed to assist in the selection of EDI translation software by combat ration producers. The work activity and status are illustrated on the attached Figure 1, CRAMTD STP#22 "EDI/CIM Model and Demonstration", Time and Event Milestones (Appendix 4.1).

2.1 Summary of STP Accomplishments

- Current business practices determined and described in Technical Working Paper TWP 95 "Electronic Data Interchange: Introduction, Concepts and Examples".
- CRAMTD provided a manned exhibit at the DPSC-sponsored EDI Conference and Trade Show, October 1994, in Philadelphia.
- Criteria for evaluating EDI translation software were developed and reported in Technical Working Paper TWP #98.
- Two complete EDI software packages were obtained and evaluated with that from TSI International, "Trading Partner PC" selected for installation.
- Following evaluation, MCI Government Systems was selected as the Value Added Network and contract signed.
- EDI functionality with the CRAMTD plant database established for Key Business Transactions.
- Outgoing EDI code 850 - Purchase Order transaction was demonstrated at the March 1995, CRAMTD Annual Contract Briefing.

3.0 Short Term Project Activities

3.1 STP Phase I Tasks

3.1.1 Current Business Practices (Task 3.3.1.1)

Because of its many technical requirements, many organizations approach EDI from a purely technical standpoint. It is quite common to see EDI implementations fall completely under the realm of MIS departments. According to most case studies and experiences, EDI affects all areas of an organization because it profoundly changes the way companies do business. R.H. Baker in "EDI, What Managers Need to Know About the Revolution in Business Communication", TAB Books, 1991, cites a number of areas that are affected by EDI implementation: Accounting, Purchasing, Sales, Legal, Production Planning, Engineering, Warehousing, and Top Management. Technical Working Paper TWP 95, "Electronic Data Interchange: Introduction, Concepts and Examples" (Appendix 4.2) describes EDI implementation and presents two examples: two commercial trading partners, and Government bidding.

3.1.2 Existing EDI Hardware/Software (Task 3.3.1.2)

EDI requires many basic components that work together to extract, package and transmit EDI messages. TWP 95 (Appendix 4.2) gives an overview of the basic software, hardware and communications components required to perform EDI transactions.

The EDI Software components consist of Database, Extract Software Utilities, Translation Software, Data Communications Software, Insert Software Utilities and Batch Control Software.

The EDI Hardware and Network Requirements consist of a Computer, Modem, and a Value Added Network (VAN) Service.

3.2 STP Phase II Tasks

3.2.1 Acquire Hardware/Software (Task 3.3.2.1)

3.2.1.1 EDI Translation Software Selection

Several EDI translation software packages were considered. Following the CRAMTD exhibit at the DPSC sponsored EDI Conference and Trade Show, October, 1994, several of the EDI component vendors were contacted and demonstration software and additional literature was obtained. The evaluation techniques reported in Technical Working Paper (TWP) #98, "Electronic Data Interchange: EDI Translation Software Evaluation", were employed as an aid to selecting the software most appropriate to our needs. For a detailed discussion of the technical and non-technical criteria, please refer to TWP #98 (Appendix 4.3).

In the CRAMTD Demonstration Facility, the development and production computers are Intel 486 class using the Microsoft DOS/Windows operating system. Candidate EDI translation software was therefore limited to that which could be implemented on the "PC" platform, excluding software packages based on mainframe or mini computer platforms.

Two complete software packages were obtained and during a trial period evaluated according to the following criteria:

Table 1: EDI Translation Software, Technical Criteria Weighting

Technical Criteria	Level	Weight
Standard Support and Compliance	1	0.2
X12 and/or EDIFACT	2	0.5
Version Support	2	0.5
Processing Architecture	1	0.05
Hardware/Operating System Support	1	0.1
Communications	1	0.05
Security	1	0.1
Documentation	1	0.1
User Interface	1	0.1
Scheduler	1	0.1
Reporting	1	0.1
Error Handling	1	0.1

Table 2: EDI Translation Software, Non-Technical Criteria Weighting

Non-Technical Criteria	Level	Weight
Software Costs	1	0.5
Translation Engine	2	0.3
Transaction Sets	2	0.2
Communications	2	0.1
Mapping	2	0.1
Scheduler	2	0.1
Maintenance	2	0.2
Technical Support	1	0.3
Hours of Operation	2	0.2
Quality of Staff	2	0.5
Extra Charges	2	0.3
Vendor Attributes	1	0.2
Market Share	2	0.2
Years in Business	2	0.4
Innovations	2	0.2
Experience	2	0.2

The raw Scores (RS) and weighted scores (WS) for the two software vendors (V1 and V2) are given in the following two tables:

Table 3: EDI Translation Software, Technical Criteria Scores

	Vendor 1		Vendor 2	
Technical Criteria	Raw	Weight	Raw	Weight
Standards Support and Compliance		2.0		1.8
Processing Architecture	9	0.45	7	0.35
Hardware/Operating System Support	8	0.8	8	0.8
Communications	8	0.4	7	0.35
Security	9	0.9	5	0.5
Documentation	9	0.9	5	0.5
User Interface	10	1.0	7	0.7
Scheduler	9	0.9	9	0.9
Reporting	10	1.0	10	1.0
Error Handling	8	0.8	8	0.8
Technical Criteria Weighted Score Total		9.15		7.70

Table 4: EDI Translation Software, Non-Technical Criteria Scores

	Vendor 1		Vendor 2	
Technical Criteria				
Software Costs	9.3	4.65	9.6	4.8
Technical Support	9.0	2.7	8.0	2.4
Vendor Attributes	8.4	1.68	8.5	1.7
Non-Technical Criteria Weight Score Total		9.03		8.9

As illustrated in the Technical and Non-Technical criteria tables, Vendor 1's superior user interface (Microsoft Windows based), security (multilevel, role based) and documentation gave it the edge over Vendor 2's software. The ease of use of the Microsoft Windows based interface represents a significant criteria when using EDI software in practice. Additional points were scored for their timely and free distribution of new EDI translation set versions and the built-in telecommunications software.

Vendor 1 in this case is TSI International and their software package is called Trading Partner PC. They have been in the EDI business 12 years and work extensively with many government agencies. Version 4.40 of Trading Partner PC was purchased in June 1995.

Installation of the software was very straightforward, consisting of the following steps:

- 1) Run the Windows based SETUP.EXE program that comes on the installation disk.
- 2) Choose a directory into which to install the main software.
- 3) Choose a directory to install the EDI transaction sets.
- 4) Choose the EDI transaction sets and versions to be used. This procedure installs templates for each of the transaction sets selected by the user.

After installing the EDI translation software, we configured two new "trading partners", one for DPSC and one for CRAMTD. Each "trading partner" is represented as an icon on the main screen. Configuring a "trading partner" requires the following information be provided:

- 1) The name of the trading partner.
- 2) A unique EDI identification number for the trading partner such as a DUNS number.
- 3) A set of EDI transactions with which the trading partner will work.
- 4) The port and hardware address of the modem used to communicate between the trading partner and the Value Added Network (VAN).

3.2.1.2 Value Added Network Selection

As discussed in Technical Working Paper TWP #95, a Value Added Network (VAN) service provides a mailbox into which EDI transactions can be stored and forwarded to and from trading partners. In order to exchange EDI transactions, two trading partners must have mailboxes on the same VAN or on VAN services that offer a connecting gateway.

As with the EDI translation software, a systematic approach was taken to choosing a VAN service provider. At the EDI trade show in Philadelphia in October 1994, we were able to meet several VAN service providers. Our main criteria for a VAN service were:

1. Connectivity with DPSC in Philadelphia. This is perhaps the most important criteria because of the goals of the Short Term Project.
2. Experience and expertise with EDI. We wanted to contract with a provider with significant prior experience with EDI and the expertise such experience brings.
3. Cost. We were somewhat conscious of cost, especially fixed monthly fees as our transaction volume would not be high. Most VAN services are billed in a similar fashion to telephone service with a fixed monthly service fee and an additional fee based on usage. In the case of VAN service, the variable portion is tied to the amount of EDI data transferred.
4. Fault Tolerance. Services that offered alternate operating procedures in the event of system failure or other down time were especially considered.

5. Gateways to other VANs. For future expansion and trading opportunities, we also wanted to consider whether a given service provider had gateways set up to other VANs.

After considering several service providers, we decided on MCI Government Systems. The compelling reasons included:

1. Had prior experience with U.S. Government EDI contracts including DPSC in Philadelphia.
2. Significant experience and expertise with EDI. Also worked closely with our chosen EDI software from TSI.
3. Relatively low fixed monthly costs.
4. Dual operating centers spread out over the United States.
5. Gateways to other VANs including AT&T's Easy Link services, another major VAN provider.

We signed a one-year contract for VAN services.

3.2.2 CIM Integration (3.3.2.2)

Once the EDI translation software and VAN service were obtained, we started to work on integrating the EDI functionality with the CRAMTD plant database. The first step in this integration was to identify the EDI transaction sets we would be required to support. The following EDI transactions were identified as key business transactions that required the support of the database. Direction shown in Table 5 indicates whether we will receive (IN) or send (OUT) these transactions:

Table 5: Key Business Transactions

Code	Transaction Set	Direction
836	Notice of Award	IN
840	Request for Quote	IN
843	Response to Request for Quote	OUT
850	Purchase Order	IN/OUT
856	Advanced Ship Notice	IN/OUT
860	Purchase Order Change	IN/OUT
865	Purchase Order Change Acknowledge	IN/OUT
810	Invoice	OUT
997	Functional Acknowledge	IN/OUT

The transaction sets shown above are not necessarily supported by all EDI trading partners, although the MCI network (VAN) is capable of sending any transaction set from the X.12 standard. A trading partner (receiving entity) may not be set up to receive certain transactions which it finds irrelevant or undesirable for conduct of business based on EDI. For example, DPSC Subsistence/Operational Rations does not use set 850 (purchase orders) since they currently only conduct large purchases and on negotiated contracts. Other agencies are restricted regarding the maximum dollar amounts for purchase orders via EDI.

For outgoing transactions, Structured Query Language (SQL) scripts are required to extract data from the plant database and to format the output to a form suitable for the EDI translation software. The Oracle SQL*Plus tool was used to carry out this function. The TSI International EDI transaction software periodically scans a default directory for any new extracted output files. When it finds a new file, a script within the TSI software reads the file and converts it to an EDI transaction file, connects to the VAN and uploads the transaction. This process can be entirely automated. An example of an outgoing 850 - Purchase Order transaction was demonstrated at the March, 1995 CRAMTD Annual Contract Briefing.

For incoming transactions, a slightly different approach must be employed. The TSI International EDI translation software is capable of automatically receiving an incoming EDI transaction and saving the enclosed data in a flat file. Scripts were written using the Oracle SQL*Loader tool to then load the incoming data into the plant database. The plant database was augmented to include extra tables to accommodate the incoming EDI transaction data. Based on this incoming data, special scripts must be created to extract relevant data and insert it into the appropriate tables that are part of the main plant database.

3.3 STP Phase III Tasks

3.3.1 Demonstrate EDI/CIM (3.3.3.1)

At the March 8, 1995 CRAMTD Annual Contract Briefing, an example of an outgoing EDI code 850 transaction "Purchase Order" was demonstrated.

During the performance period of the STP, CRAMTD was unable to establish a Trading Partner relationship with Subsistence at DPSC. Following the conclusion that a Subsistence presence in EDI was not sufficiently active, discussed a test relationship with Clothing and Textiles but that was unsuccessful due to a lack of time.

The National Institute of Science and Technology (NIST) pilot EDI effort, similarly, did not reach the stage where participation was possible. The common interest was definition of the EDI transaction set for product description (product quality) data.

Resources at the CAFT Food Manufacturing Technology Facility (Demonstration Site) will continue consideration of EDI and establish a Trading Partner when feasible.

3.3.2 Identify Technology Transfer Partners (3.3.3.2)

TSI International has been in the EDI business 12 years and their Trading Partner PC software was implemented at the Demonstration Site. MCI Government Systems was selected as the Value Added Network (VAN) resource. MCI has prior experience with Government EDI contracts including with DPSC.

3.3.3 Provide Technical Guidance (3.3.3.3)

Two Technical Working Papers were prepared and distributed: "Electronic Data Interchange: Introduction, Concepts and Examples" (TWP 95) and "Electronic Data Interchange: EDI Translation Software Evaluation" (TWP 98).

At such time as active Trading Partner relationships are closer to being established in Operational Rations, the CAFT Food Manufacturing Technology Facility (Demonstration Site) can provide workshops. In concert with DPSC Procurement activities, the Demonstration Site under CORANET DEMO and a CORANET Short Term Project can also undertake a proactive role in supporting Combat Ration Producers becoming Trading Partners to DPSC. The Vendor Evaluation System (see Final Technical Report FTR 20.0, "Vendor Evaluation System", STP #60. Available from The Center for Advanced Food Technology, 120 New England Avenue, Piscataway, NJ 08854, Phone (908) 445-6130, FAX (908) 445-6145) will also require electronic transfer of information. Establishing a capability for such transfers should maximize compatibility between hardware and software requirements.

4.0 Appendix

- 4.1 Figure 1 CRAMTD STP #22 Time and Events Milestones**
- 4.2 Technical Working Paper (TWP) 95, "Electronic Data Interchange: Introduction, Concepts and Examples"**
- 4.3 Technical Working Paper (TWP) 98, "Electronic Data Interchange: EDI Translation Software Evaluation"**

Figure 1 - CRAMTD Short Term Project #22
EDI/CIM Model and Demonstration
Projected Time & Events and Milestones

Task Name	Reference	1994						1995					
		Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Phase I Analysis/Definition													
Current Business Practices	3.3.1.1												
Existing EDI Hardware/Software	3.3.1.2												
Phase II Acquisition/Development													
Acquire Hardware/Software	3.3.2.1												
CIM Integration	3.3.2.2												
CRAMTD Coordination	3.3.2.3												
Phase III Demonstration													
Demonstrate EDI/CIM	3.3.3.1												
Identify Transfer Partners	3.3.3.2												
Provide Technical Guidance	3.3.3.3												
Final Technical Report	3.3.3.4												

COMBAT RATION ADVANCED MANUFACTURING TECHNOLOGY DEMONSTRATION (CRAMTD)

Electronic Data Interchange: Introduction, Concepts and Examples

Technical Working Paper (TWP) 95

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Contents

1	Introduction	4
2	EDI: History and Definitions	4
2.1	Definitions of EDI	5
2.2	EDI Benefits to Business	6
2.2.1	Quantifiable Benefits to Business	6
2.2.2	Qualifiable Benefits to Business	7
3	EDI Implementation Methodology	8
3.1	Business Issues	8
3.2	Implementation Steps	9
3.2.1	The Planning Stage	9
3.2.2	The Acquisition and Development Stage	10
3.2.3	The Pilot Stage	10
3.2.4	The Full Implementation Stage	10
4	EDI Basic Components	10
4.1	EDI Software Components	11
4.2	EDI Hardware and Network Requirements	13
4.3	Value Added Network Services	14
5	EDI Standards	16
5.1	ANSI Accredited Standards Committee - X12	16
5.1.1	History of ANSI ASC X12	16
5.1.2	ANSI ASC X12 Functions	16
5.1.3	X12 Standards Components	17
5.2	International Standards - EDIFACT	18
5.2.1	History of EDIFACT	18
5.2.2	EDIFACT Functions	19
5.2.3	EDIFACT Standards Components	19
5.3	Merging Standards	21
6	Examples of EDI Transactions	22
6.1	Example 1 - Purchase Order	22
6.2	Example 2 - Government Bidding	28
7	EDI Challenges	29
7.1	Compatibility	29
7.2	U.S. Government Demands	30
7.3	Small Business	31
7.4	Trading Partner Agreements	31

8	Appendix I - ANSI ASC X12 Transaction Sets	34
9	Appendix II - EDIFACT Transaction Sets	41
10	Appendix III - EDI Resources Directory	43
11	Glossary	45

List of Figures

1	Flow of Data showing EDI Components	11
2	Trading Partner to Trading Partner Direct Network Connections . . .	14
3	Trading Partner to VAN Network Connections	15
4	Building Blocks of an ANSI ASC X12 Standard	17
5	Control Segments used in the ANSI ASC X12 Standard	18
6	Building Blocks of an EDIFACT Standard	20
7	EDI Information Flow Between Hats R Us and Fabric City	23
8	Purchase Order From Hats R Us	24
9	Flat ASCII File Representation of the Hats R Us Purchase Order . .	25
10	EDI Transaction (set 850) for the Hats R Us Purchase Order	26
11	The Hats R Us Customer Order in Fabric City's Database	27

1 Introduction

Most companies operating in the world today make use of paper documents that represent binding contracts to provide goods and services to other organizations and individuals. It has been recognized that although information systems can be of tremendous benefit to storing and cataloging the data from such documents, the exchange of business documents is still prone to mishandling, delivery delays and data entry errors.

Electronic Data Interchange (EDI) is the term given to the exchanging of business documents, by standardized electronic means, between trading partners. The use of EDI has been credited with reducing delivery times and data entry errors by eliminating the need for human intervention for most of the common business transactions [Emm90].

This paper is designed to:

1. Give an introduction to EDI concepts and terminology;
2. Give some examples of actual EDI message exchanges;
3. Provide some guidelines for first time users of EDI and those who may be planning to implement EDI in their organization; and
4. Provide a collection of resources for individuals who would like to find out more about EDI.

2 EDI: History and Definitions

Typical business uses for computers include the entry, storage, retrieval and printing of data that is critical for the operations of the business. Purchase Orders, Customer Orders, Invoices, Shipping and Receiving and other information is typically entered by a human operator and stored on a computer system. Later this same information may be printed out, placed in an envelope and mailed to another company. Once at its destination, the envelope is opened, the contents removed and finally, the information is read off of the document and entered into another computer system. Such exchanges are carried out countless times each day all over the world.

There are, however, some inherent problems with these procedures. For example:

1. Information must be entered at least twice; once by the originating company and once by the destination company.
2. Data entry is prone to human error.
3. Exchanging paper documents takes on the order of days by regular mail or at least overnight by costly express mail.

Each of these problems results in time delays for processing paper documents. Such delays result in uncertainty for production planning, poor customer service and inflated inventories (buffers) required to cover for inaccurate or untimely data [SS92].

In the 1960s, these shortcomings began to gain attention as large manufacturers in the U.S. auto industry and international shipping companies began to see their industries burgeon. For a large auto maker with hundreds or thousands of parts suppliers, managing all of the outgoing purchase orders and incoming invoices soon became a mammoth task. It was in the 1960s when the transportation industry began to form some standards for the exchange of these common business documents via communication networks.

The first standards created were aimed at standardizing the documents used within particular industries. These included transportation and financial services. By the end of the 1960s, however, it was discovered that many similarities existed *across* these and other industries giving rise to interest in national standards [Dat93].

Since the 1970s, the American National Standards Institute (ANSI) has managed the creation and maintenance of EDI standards through the Accredited Standards Committee (ASC) group designated as X12. In 1985, a world-wide effort to standardize EDI transactions was formalized when the United Nations formed the Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT) committee [Can93]. Additional details of these two standards groups are given in sections 5.1 and 5.2.

2.1 Definitions of EDI

Although most individuals agree on the basic concepts behind EDI, there have been many definitions put forth to describe it. Here are a few examples:

- “EDI is the exchange of routine business transactions in a computer-processable format, covering such traditional applications as inquiries, planning, purchasing, acknowledgements, pricing, order status, scheduling, test results, shipping and receiving, invoices, payments, and financial reporting.” [Dat93]
- “The standards based computer-to-computer exchange of intercompany business documents and information.” [Coa88]
- “...computer-to-computer transmission of standard business data.” [Emm90]
- “EDI is defined as the exchange of computer processable data in a standard format between organizational entities.” [GT94]
- “Electronic data interchange (EDI) is the computer-to-computer exchange of routine business information using Accredited Standards Committee (ASC) X12 standards.” [HH93]

Several things are clear from these examples of EDI definitions. The business transactions must indeed be in some common or standard format such that they can be automatically processed by computer applications. What is also implied is that human intervention should not be required in order to process the documents. It is also clear that the business documents themselves have some commonality across most if not all industries. For example, the purpose and structure of an invoice should be agreed upon by all business hoping to exchange invoices electronically via computer applications.

What is not clear from these definitions is the various hardware and software components required to make EDI work. These components will be discussed in section 4 starting on page 10.

2.2 EDI Benefits to Business

It would be difficult to justify the adoption of EDI without some quantitative and qualitative benefits to the organization. The following benefits are described in a general fashion as companies may perceive such benefits to different degrees. Most of the general business literature on EDI supports these claims.

2.2.1 Quantifiable Benefits to Business

All of the following benefits of using EDI lead to cost savings either directly or indirectly through reduced man-hour requirements (summarized from [SS92], [Dat93] and [HH93]).

- Using EDI shortens the processing time for incoming and outgoing business documents.
- Using EDI lowers requirements for paper, printing supplies and postage.
- Using EDI reduces costs for storage and filing.
- Using EDI lowers requirements for the number of data processing and clerical staff such as order entry personnel.
- Using EDI increases the quality of the data in information systems. Data entry errors are eliminated.
- Using EDI can allow for lower inventory levels to be maintained since ordering cycles are much shorter.

2.2.2 Qualifiable Benefits to Business

The quantifiable benefits listed above may lead to the following benefits for an organization that adopts EDI.

- Better customer response [SS92]. Customers can receive better quality information such as order or delivery status.
- Uniform communications with all trading partners [Dat93]. Fewer but more robust avenues of communication may simplify communications. For example, the U.S. Department of Defense (DoD) has made steps to move to completely automated bidding and contract negotiation systems using EDI [HH93].
- Increased business opportunities. When dealing with government contracts, Requests for Quotations (RFQs) are frequently distributed to potential suppliers. Receiving RFQs electronically via EDI can allow a supplier to evaluate more RFQs and to generate bids in response [HH93].

There are many “success stories” that have been printed about EDI. Summaries of a few of these are given here:

- (This example is taken from [Bak91]) An early adopter and EDI vanguard, the General Motors Corp. (GM) began exchanging electronic purchase orders with one of its largest parts suppliers, PPG, in the 1960s. Today EDI transactions based on ANSI ASC X12 standards are exchanged on a regular basis with over 6,000 customers in 26 countries. The following benefits have been realized:
 - Cut payment cycle by eight to ten days.
 - Payments disputes dropped to less than 4% and disputes take much less time to resolve.
 - Payments are made almost immediately. There is no need to wait until the following “billing cycle.”

A GM subsidiary, Electronic Data Systems (EDS) is now in the business of supporting EDI systems worldwide [Bak91].

- (This example is taken from [HS91]) The Norwegian customs clearance system called TVINN (Tollekspeidisjon Ved INNførsel or “customs clearance at import”) uses UN/EDIFACT EDI messages to streamline the paperwork required for importing goods. The system allows customs clearance documents to be filed electronically via EDI messages. The system has been running since 1988 and has provided the following benefits in reference to the handling of customs clearance documentation [HS91]:

- Reduction in customs clearance document handling time.
 - Improvement in failure control when customs documentation is incomplete or erroneous.
 - Reduction in document handling and storage costs.
- According to Peter Wayner, a consulting editor for BYTE magazine: “An internal study by a Fortune 500 firm showed, for example, that the company could save \$500 to \$700 million with a corporate-wide EDI system” [Way94].

3 EDI Implementation Methodology

Implementing EDI requires more than simply installing some computer hardware and software. Proper planning and testing of systems and procedures is required to increase the chances for success and to achieve the potential benefits described in previous sections. This section of the paper will provide a step by step approach to preparing, planning, testing and installing an EDI system.

3.1 Business Issues

Because of its many technical requirements, many organizations approach EDI from a purely technical standpoint. It is quite common to see EDI implementations fall completely under the realm of MIS departments. According to most case studies and experiences, EDI affects all areas of an organization because it profoundly changes the way companies do business. Baker cites several areas that are affected by EDI implementation ([Bak91] page 77):

- Accounting
- Purchasing
- Sales
- Legal
- Production Planning
- Engineering
- Warehousing
- Top Management

The guidelines presented below take these diverse groups into account when planning an EDI implementation.

3.2 Implementation Steps

The successful implementation of an EDI project can be broken down into four main stages: Planning, Acquisition and Development, Pilot and Full Implementation. Of the four, the planning stage is the most critical and may actually take the longest time to complete.

3.2.1 The Planning Stage

The Planning stage is where all of the background research into the organizational and technical impact of EDI is conducted. Because of EDI's profound effect on an organization (see previous section) consideration must be paid to all of the areas that may be affected by an EDI implementation.

Some of the action items to be carried out in the planning stage include:

- Diagram the current flow of paper documents in and out of the organization. Identify as many "paper trails" as possible. Indicate which departments and personnel are responsible for "touching" these documents as they pass through the organization. Also indicate where appropriate controls are in place or need to be added. For example purchase orders may not leave the organization unless signed by a purchasing manager.

Identifying these paper trails should shed light on potential areas where EDI can benefit the most. If appropriate controls need to be added, do so right away. EDI is not a fix for whatever problems may exist in the current paper flow.

- Identify key personnel along the current paper trails. Be aware that the personnel requirements for certain tasks, such as order entry, will be reduced considerably while, in other areas, new jobs may be created.

It is important to deal with these ramifications before they become "political issues" [Bak91].

- Identify the training and re-training requirements for the organization. New tasks will need to be performed by current personnel. Assume that all related personnel will require some degree of training in new procedures.
- Make a list of potential EDI trading partners. Visit their sites and learn how committed they are to doing business via EDI. Rank this list in order of EDI competency. Those trading partners at the top of the list will be potential candidates for the Pilot stage.
- Gather the technical requirements for hardware, software and networking. These choices may be dictated by existing systems already in place and may be otherwise influenced by the software and communications networking choices (i.e., Value Added Network provider (VAN)) made by potential trading partners.

Other considerations can be found in [HH93].

3.2.2 The Acquisition and Development Stage

In this stage, the hardware and software components are chosen based on requirements taken from the planning stage and hardware and software supplier evaluations. The actual components required to make EDI work, including the basic features of EDI translation software, are discussed in section 4 of this technical working paper starting on page 10. The methodology and criteria for selecting EDI translation software, a major component of any EDI implementation, will be given in another technical working paper.

Any utilities, such as extract and insert routines, that need to be written in-house, are also created during this stage.

At the end of this stage, the software and hardware components should be installed and operational. Testing must be done to ensure that all utilities perform correctly and that communications with the Value Added Network provider or direct links to trading partners work as planned.

3.2.3 The Pilot Stage

During the Pilot stage, EDI transactions are carried out with one or two trading partners. Ideally, the first trading partners will have prior EDI experience. This can be a great help in ironing out compatibility issues, software bugs and other procedural issues. Contingency plans should be made in the event EDI transactions are lost or corrupted in transmission.

During this time, all other systems are run in parallel with EDI. For example, order entry functions should continue as before. This support is necessary since the majority of other trading partners will still be submitting paper documents. EDI implementations are very rarely "cut-over" from paper based to electronic based exchanges in one step.

3.2.4 The Full Implementation Stage

If all goes well in the Pilot stage, more trading partners can be added, usually one at a time. During this time, the level of support required for incoming and outgoing paper documents should begin to fall off.

Once again, attention must be paid to the organizational changes that occur as less emphasis is placed on the handling of paper documents.

4 EDI Basic Components

EDI requires many basic components that work together to extract, package and transmit EDI messages. In some systems, the functionality of these components are combined in one subsystem. This section is intended to give an overview of the basic software, hardware and communications components required to perform EDI

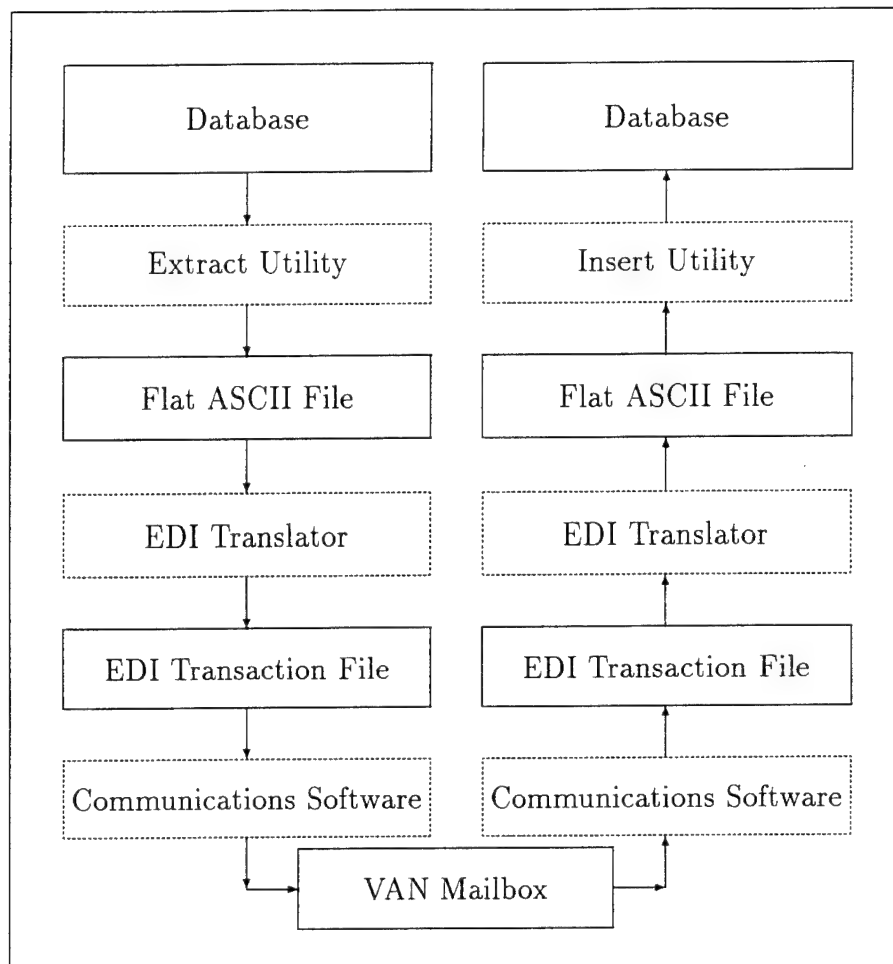


Figure 1: Flow of Data showing EDI Components

transactions. For a concrete example of EDI using these components please refer to section 6 starting on page 22.

4.1 EDI Software Components

The following section contains descriptions of the software components and their purpose in an EDI system. Many businesses will already have some of the software components, such as a database, already in place. Other software components must be purchased from commercial sources or written by the organization's MIS or computer programming staff.

Figure 1 gives a general outline of the flow of data through an EDI system.

Database Each trading partner should maintain a database capable of storing data

corresponding to the business documents they wish to exchange. For example, a purchasing database will contain tables capable of storing purchase order header information, purchase order detail information, parts and product lists and company information for each trading partner.

A database will also require some data entry screens that allow users to enter and retrieve data from the database. For example, a data entry screen that enables a user to look up and change current product prices would be necessary. Reporting capabilities are also required to produce larger collections of data that can be viewed on screen or printed out. For example, a monthly report might be created showing the number of customer orders received broken down by product number.

Databases can be created using a variety of commercial database development tools such as Paradox, FoxPro, Access, Approach, Clipper, dBase, Oracle, Sybase, Ingres, DB/2 and others (Note: All trademarks of their respective companies). Such software ranges in cost from a few hundred dollars for PC databases to hundreds of thousands of dollars for mainframe databases.

Extract Software Utilities These software utilities are capable of extracting data from the database tables into specially formatted flat ASCII files. This is done in preparation for the translation step. Typically, such utilities are included with commercial database software tools. It is also possible that a utility will have to be custom programmed to accomplish the task. Often it is necessary to have a different extract utility for each type of transaction to be exchanged.

Extract (and Insert) software is sometimes referred to as **Mapping** software because it maps the data in the company database to specific fields in an EDI transaction. For example, in a purchasing database, the purchase order number is mapped to the appropriate location in the EDI transaction file. Typically the job of mapping a database to various EDI transactions is done only once. The results of this step are then used to generate the extract and insert software utilities.

Translation Software For outgoing messages, the translation software reads in a flat ASCII file extracted from the database and writes out an EDI transaction file that contains all of the special data element and segment delimiters that correspond to the transaction set.

For incoming messages, the translation software reads in an EDI transaction file, strips the EDI specific codes off of the file and writes a flat ASCII file suitable for an insert utility to use as input.

These actions rely on adherence to the EDI standards (ANSI ASC X12 or EDIFACT) to perform the translation. Often the translations are carried out with slightly different codes depending on the individual needs of the trading partner.

Some translation software packages can perform the job of the extract and insert software utilities as well as the translation functions.

Data Communications Software This software is responsible for connecting the organization's computers to a remote host or Value Added Network (VAN) and for uploading or downloading messages to and from the trading partner or VAN mailbox (described below).

Insert Software Utilities These utilities get their input from the flat ASCII file produced by the translation software after an incoming message has arrived. These utilities perform the reverse job of the extract software utilities in that they take data from the ASCII files and *insert* the data into the database.

Batch Control Software Although this software component is optional, most systems include some type of batch control to coordinate the extract, translate and data communications steps. This software may also include timers that trigger the execution of these steps at user defined intervals during the day. For example, a user could set the communications software to dial up the VAN mailbox and download any new EDI messages every two hours.

4.2 EDI Hardware and Network Requirements

The software systems described above rely on computer and telecommunications hardware to help carry out the exchange of EDI messages. There are many computer hardware systems on the market and an exhaustive presentation is beyond the scope of this paper. The following is a general description of the various hardware components required.

Computing Platform In the 1960s and 1970s, mainframes and minicomputers were used to run the database, extract/insert utilities, EDI translation software and communications software. This is still feasible today and many companies operate in this fashion.

In the late 1970s and 1980s, the personal computer (PC) market began to accelerate giving inexpensive processing power in affordable and manageable packages. For small businesses, personal computers attached to local area networks (LAN) are the mainstay of the business. There are many EDI translators and database products that operate on a PC platform. For companies just starting up or for those with limited budgets for EDI hardware, PCs make an excellent choice.

In many cases, the existing computer hardware will dictate the choices in future computer and software purchases. A company that is perfectly happy with their minicomputer will tend to develop EDI applications on the same machine.

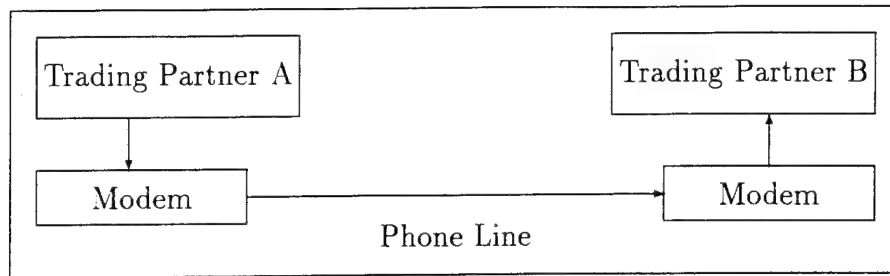


Figure 2: Trading Partner to Trading Partner Direct Network Connections

A detailed comparison of the features and merits of the various computer platforms is beyond the scope of this paper.

Communications Equipment Communications equipment is used to link an organization's computers to either a Value Added Network (VAN) provider or directly to trading partners for the purposes of transmitting and receiving EDI transaction messages.

In either case (VAN or direct connection), a **modem** (MODulator DEModulator) is employed. Modems are capable of converting the digital signals produced by a computer into analog signals that can be transmitted across telephone lines. A modem at the other end then converts the analog signals back to digital form.

Figure 2 shows the direct connection (called point-to-point) between two trading partners using modems and an ordinary phone line. This setup has the advantage of low cost because no "middle man" (the VAN) is used to temporarily store the EDI transactions (please see the following example). However, it is possible that when trading partner A attempts to connect with trading partner B, another party is in the process of sending some transactions. In this case trading partner A will literally receive a "busy signal" and will have to try again at a later time.

Another shortcoming of this point-to-point method of communicating is the problem of configuring possibly incompatible modems. As more trading partners wish to exchange EDI transactions, the number of possible connections (and, hence conflicts) grows dramatically.

4.3 Value Added Network Services

Value Added Network (VAN) services such as VAN Mailboxes can be used to alleviate some of the problems encountered with the point-to-point connection described in the previous example. When used for the purposes of EDI, VANs can provide *Mailboxes* that are capable of storing electronic mail and EDI transactions. These electronic

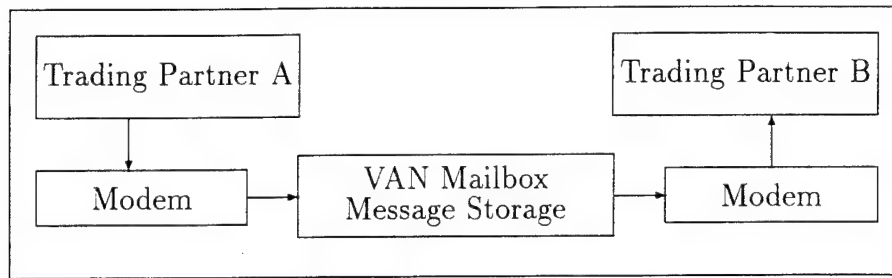


Figure 3: Trading Partner to VAN Network Connections

mailboxes work just like “real” mailboxes in that mail may be placed in them at any time. The mail will then stay in the mailbox until someone is ready to retrieve it.

There are a number of VAN service providers that offer VAN mailboxes. It is important that all of the trading partners that wish to exchange EDI transactions use the same VAN provider or use VAN providers that offer a *gateway* to other VANs so that mail and EDI transactions can be forwarded to the proper destination.

Figure 3 shows the network connections between two trading partners and a VAN provider. In this scenario, trading partner A will create an EDI transaction file (such as an invoice) and use the modem to *upload* this file to the VAN. The file is placed in a VAN *mailbox* assigned to trading partner B. The file will remain in the VAN mailbox until it is retrieved. Some time later, trading partner B will use their modem to *download* the EDI invoice transaction from the VAN mailbox and then process the EDI transaction.

By using a VAN mailbox, trading partner A can upload EDI transactions at any time. For example, they may gather several EDI transactions and upload them at night when the phone rates are cheaper. Similarly, trading partner B can download one or more EDI transactions when it is convenient or least costly.

5 EDI Standards

EDI standards provide a common language that allows trading partners to communicate electronically. In the past, many companies used proprietary formats to communicate with each of their trading partners. Since a company often has more than one trading partner, many different proprietary formats had to be maintained by a single trading company. The result was high maintenance cost.

An earlier alternative to this problem was to develop industry-specific standards. However, this was still not a good solution as many companies trade with companies outside of their own industry. Therefore, they still had to use several different standards. There was a need for national standards.

In 1979 the American National Standards Institute (ANSI) began developing the ASC X12 standards for EDI. At the same time, with the emergence of many multinational companies and with the growing global economy, there was a pressing need for international standards. In 1985 the United Nations began developing EDIFACT. In the next several subsections we shall describe these standards.

5.1 ANSI Accredited Standards Committee - X12

5.1.1 History of ANSI ASC X12

In 1979 the American National Standards Institute chartered the Accredited Standards Committee with the task of developing EDI standards. The objective was to merge the industry-specific standards (e.g., transportation industry standards published by the Transportation Data Coordinating Committee (TDCC) or auto industry standards published by the Automobile Industry Action Group (AIAG)) and also to develop new general purpose standards [Can93]. The first version of the X12 standards, developed by ASC, were approved by ANSI in 1983 [Dat93].

5.1.2 ANSI ASC X12 Functions

The Accredited Standards Committee X12 meets three times a year to discuss new proposals for EDI standards. New transaction sets can be proposed and existing standards can be augmented with new data elements. The implementation of a new transaction set or the changes to an existing set follow this path [Cro95]:

1. An individual, an organization or some recognized group (such as the AIAG) drafts a memo of the proposed changes or additions that will affect an X12 standard. This memo, called a *Data Maintenance Request*, presents the justification for the change and is sent directly to the ASC for consideration in the next meeting.
2. The ASC will hand over the request to a specific subgroup within the ASC for closer review.

```
Transaction Begin
  Data Segment 1 Begin
    Data Element A
    Data Element B
    Data Element C
  Data Segment 1 End
  Data Segment 2 Begin
    Data Element D
    Data Element E
  Data Segment 2 End
Transaction End
```

Figure 4: Building Blocks of an ANSI ASC X12 Standard

3. At the next meeting, all of the proposed changes received since the last meeting are discussed. All members debate the pros and cons of adopting the change or addition. A final vote is taken on the matter.
4. If the change is accepted, it will be published by the ASC. If the change is not accepted, then the sponsoring group can make revisions and resubmit the proposal for consideration at the next meeting.

5.1.3 X12 Standards Components

The *Data element* is the basic building block of the ANSI ASC X12 standards. Data elements are combined to make a *data segment*, and data segments are combined to form an EDI *transaction* as seen in Figure 4.

For a transaction to be acceptable by the EDI standards, all the data elements must be defined within the X12 standards. To create and use new data elements which are not already defined in the standards, a formal request must be made to the ASC X12 committee.

It is possible that, due to line noise or interference, an EDI transaction could become corrupted during transmission. In order to guard against lost data and to improve failure control under these circumstances, X12 transactions are augmented with three levels of *control segments*, also called *envelopes*. The three levels of control segments are:

Transaction Set Wraps around an individual EDI transaction and contains information about the type of transaction (e.g. Invoice).

Functional Group Wraps around one or more transaction sets of the same type.

Interchange Header

Functional Group Header

Transaction Set Header

Transaction (Invoice 1)

Transaction Set Trailer

Transaction Set Header

Transaction (Invoice 2)

Transaction Set Trailer

Functional Group Trailer

Functional Group Header

Transaction Set Header

Transaction (Payment Notice)

Transaction Set Trailer

Functional Group Trailer

Interchange Trailer

Examples of transactions such as Invoice and Payment Notice are given in parentheses.

Figure 5: Control Segments used in the ANSI ASC X12 Standard

Interchange Wraps around the entire EDI message (around all functional groups) and includes all of the information required to deliver the EDI transaction to its destination.

An outline of the control segments used in the ANSI ASC X12 standard can be seen in Figure 5. A list of transaction sets contained in the ANSI ASC X12 standard is given in Appendix I starting on page 34.

5.2 International Standards - EDIFACT

5.2.1 History of EDIFACT

As the ANSI ASC EDI standards were beginning to win mass acceptance in North America in the mid 1980s, individual countries began to work together under the United Nations (UN) to form international standards for electronic messaging.

As recently as 1985, the United Nations Economic Commission for Europe (UN/ECE) approached the ANSI ASC X12 committee with the intent to work together to form global EDI standards. In 1986, the Electronic Data Interchange for Administration,

Commerce and Transport (EDIFACT) committee was formed for the purposes of carrying out this mission [Kim91].

By 1989, member nations included all of North America and many countries in Europe, South America and the Pacific Rim. Message structures covering most of the major business functions have since been created [Kim91].

5.2.2 EDIFACT Functions

The EDIFACT committees meet on a schedule similar to their ANSI ASC X12 counterparts in the U.S. With member countries spanning the globe, meetings are held in alternating locations several times a year. The content of the meetings is again similar to that of the ASC X12 gatherings. New transactions are proposed and changes or additions to existing standards are debated.

Since the standard transactions must apply to diverse industries across nations, the procedures for proposing an addition or change are slightly different [Cro95]:

1. Within a given country, the local standards bureau (such as the ANSI ASC committee in the U.S.) first approves the proposed addition or change to an EDIFACT standard.
2. Once approved at the local level, the request is submitted to the UN/EDIFACT committee for consideration at the following meeting.
3. At the next meeting, all of the proposed changes received since the last meeting are discussed. All members debate the pros and cons of adopting the change or addition. A final vote is taken by all of the member countries on the matter.
4. If the change is accepted, it will be published by the UN/EDIFACT committee. If, however, any country does not agree with the changes or additions, the proposal must be rewritten and debated again at the following meeting.

Because of the lengthy and thorough review process and the challenge of meeting the needs of many member countries, progress on the EDIFACT standards is generally a very slow process.

5.2.3 EDIFACT Standards Components

The EDIFACT standards appear to be similar in form to the ANSI ASC X12 transactions. There are, however, a few subtle differences in terminology.

As with X12, the basic structure of an EDIFACT message is the *data element*. A data element contains a single data value such as a phone number or company name. A *segment* is a logical group of data elements such as a "Bill To" address. An EDIFACT *message* contains a group of segments that represent a business document such as a purchase order [TS92]. Note that while EDIFACT uses the term message, X12 prefers the term transaction.

Interchange Header

```
Functional Group Header
  Message Header
    Segment (DE, DE, DE, DE)
    Segment (DE, DE, DE, DE)
  Message Trailer
  Message Header
    Segment (DE, DE, DE, DE)
    Segment (DE, DE, DE, DE)
    Segment (DE, DE, DE, DE)
    Segment (DE, DE, DE, DE)
  Message Trailer
Functional Group Trailer
```

```
Functional Group Header
  Message Header
    Segment (DE, DE, DE, DE)
    Segment (DE, DE, DE, DE)
  Message Trailer
Functional Group Trailer
```

Interchange Trailer

Where DE = Data Element

Figure 6: Building Blocks of an EDIFACT Standard

An *interchange* is a group of one or more messages that is sent from one trading partner to another. Each message can be of a different type within the interchange. For example, an interchange might include a purchase order and a payment receipt. A *functional group* is an interchange where all of the messages are the of the same type [TS92].

Each of these structures has a beginning code and ending code associated with them. These codes are called *Headers* and *Trailers* respectively. An outline of an EDIFACT structure can be seen in Figure 6.

A listing of EDIFACT standards based on version D93.A are given in Appendix II starting on page 41.

5.3 Merging Standards

It is clear that although the U.S. was the first country to make widespread use of EDI and EDI standards, the needs of the global economy have taken precedence. For EDI standards, this manifests itself in the need to merge the ANSI ASC X12 and EDIFACT standards into a single cohesive standard.

The existing transactions in EDIFACT include all of the functionality of the corresponding X12 transaction and are, in most cases, a generalization of the X12 transaction sets. Because of this, the merging of the two standards has become more of a transition from X12 to EDIFACT. This is accomplished by broadening the EDIFACT standards to retain the same functionality in the X12 standards.

There is a reluctance to change over to the EDIFACT standard due to the existing investment made by U.S. industries in ASC X12 compliant software and systems.

6 Examples of EDI Transactions

In previous sections, descriptions, benefits and definitions of EDI implementations have been given. In this section, a detailed example of a simple EDI transaction session will be given. Another example of a longer term exchange of EDI transactions will also be shown.

6.1 Example 1 - Purchase Order

For this example, assume that two trading partners wish to use EDI for the purposes of sending and receiving purchase orders. The first company, *Hats R Us* is a manufacturer of hats while the second *Fabric City* is a supplier of fabric. The hat manufacturer maintains a manufacturing database on a minicomputer that includes a Purchasing system capable of creating and storing purchase orders. The fabric supplier has a database for maintaining customer orders and shipping information on a personal computer local area network. Both partners have agreements with the same VAN service company to transmit the EDI transactions. Both partners have also agreed to use the ANSI ASC X12 transaction set.

The scenario for this example depicts the hat manufacturer's purchase order being sent to the fabric supplier. Figure 7 shows the basic flow of information between the two trading partners. The steps required for this transaction are as follows:

1. A purchasing agent from the hat manufacturer creates a purchase order for some fabric indicating *Fabric City* as the intended supplier. A sample PO data entry screen can be seen in Figure 8.
2. At a predetermined time each day, a mapping routine written by *Hats R Us'* MIS staff extracts new purchase orders from the purchasing database into a flat file. The flat file corresponding to the PO can be seen in Figure 9.
3. The EDI Translation software, purchased from a commercial software vendor, reads the flat file and reformats the file into an EDI transaction. This is accomplished by inserting the appropriate X12 standard codes for the 850 transaction set (Purchase Order) in the transaction file.

Additional information is added to the EDI transaction from information about specific trading partners held in a small database maintained by the EDI translation software. The final EDI transaction file can be seen in figure 10.

4. At this point, the EDI transaction is packed and ready to be delivered by dialing a modem to the VAN and uploading the EDI transaction file to an electronic mailbox owned by *Fabric City*.

Once the PO has been successfully uploaded to the VAN, it will remain in the mailbox until it is downloaded as a customer order by *Fabric City*.

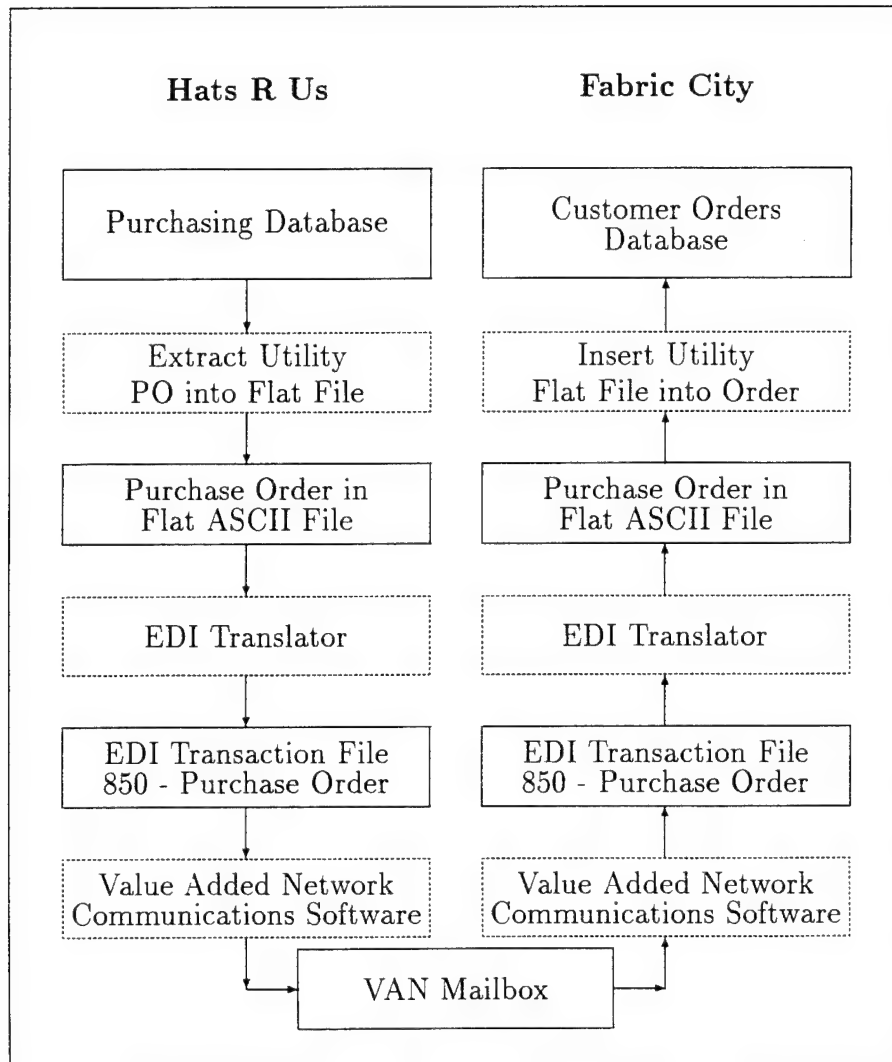


Figure 7: EDI Information Flow Between Hats R Us and Fabric City

+-----+			
Hats R Us Purchase Order	Date: July 1, 1994		
123 Bowler Lane	PO Num: 912-111		
Fedora, TN 01234	+-----+		
	Sub-Total: \$3,000		
Vendor: Fabric City	Shipping: 100		
456 Paisley Park Drive	-----		
Plaid, NB 98765	Total: \$3,100		
+-----+			
Item Part	Description Qty.	Cost	Total
-----	-----	-----	-----
1 534-32	Terrycloth 1000 yd.	\$1.00	\$1,000.00
2 524-31	Linencloth 1000 yd.	\$2.00	\$2,000.00
+-----+			

Figure 8: Purchase Order From Hats R Us

5. *Fabric City* has a program that automatically polls the VAN mailbox for new messages. When a new message is found, it is downloaded and saved as an incoming EDI transaction.

The EDI transaction file looks identical to the file uploaded by *Hats R Us*.

6. The EDI translation software now goes to work to unpack the PO transaction and to save the relevant parts into a flat ASCII file.

Again, this flat ASCII file looks identical to the file produced by *Hats R Us*.

7. Since the incoming file is a purchase order, *Fabric City* is required to treat this file as a *customer order*. The database mapping routine maps the incoming purchase order into the customer order portion of the database.

The final customer order can be seen in the *Fabric City* database in figure 11.

```
ponumber: 912-111
date: July 1, 1994
fromname: Hats R Us Purchase Order
fromaddress1: 123 Bowler Lane
fromaddress2: Fedora, TN 01234
tovendorname: Fabric City
tovendoraddress1: 456 Paisley Park Drive
tovendoraddress2: Plaid, NB 98765
sub-total: 3000
shipping: 100
totalPO: 3100
item: 1
part: 534-32
description: Terrycloth
quantity: 1000 yd.
cost: 1
itemtotal: 1000
item: 2
part: 524-31
description: Linencloth
quantity: 1000 yd.
cost: 2
```

Figure 9: Flat ASCII File Representation of the Hats R Us Purchase Order

```

ISA*00*0000000000000000*01*password*01*12345678*dun1234*
      *890714*2210*U*0020*000000000008**0*P*:
GS*IN*12345678*940701*900959*2212*0000001*X*002040
ST*850*00001
BIG*940701*912-111
N1*BT*Hats R Us
N2*123 Bowler Lane
N3*Fedora, TN 01234
N1*SE*Fabric City
N2*456 Paisley Park Drive
N3*Plaid, NB 98765
IT1*1000*YD*1.00*VC*534-32
IT1*1000*YD*2.00*VC*524-31
TDS*3100
CTT*2*20
SE*21*00000001
GE*1*00000001
IEA*1*000000000008

```

The line starting with ISA is the Interchange Control Header. The line starting with GS*IN is the Functional Group Header. The line starting with ST*850 is the Transaction Set Header indicating set number 850 is being used.

Figure 10: EDI Transaction (set 850) for the Hats R Us Purchase Order

```

+-----+
|                                     |
|               Customer Order Screen |
|               -----               |
| Customer: Hats R Us                Date: July 1, 1994 |
|           123 Bowler Lane          |
|           Fedora, TN 01234          |
|                                     |
| Sub-Total: $3,000                  Order Number: 1001 |
| Shipping:      100                  Taken By: via EDI |
|           -----                  |
| Total:         $3,100              |
+-----+
| Item Part  Description Qty.      Cost    Total |
| -----  - - - - - - - - - - - - - - - - - - |
|  1   534-32 Terrycloth  1000 yd. $1.00   $1,000.00 |
|  2   524-31 Linencloth  1000 yd. $2.00   $2,000.00 |
+-----+

```

Figure 11: The Hats R Us Customer Order in Fabric City's Database

6.2 Example 2 - Government Bidding

This example of a series of EDI transactions will demonstrate the full lifecycle for a U.S. government agency bid for products. In the previous example, the details for the mapping, translation and transmission of EDI messages were described. In this example, several rounds of EDI messages are described but the message details have been omitted for brevity. A more general example of governmental EDI can be found in section 3.4 of [imp94].

When a government agency wishes to purchase a large quantity of materials it usually must solicit bids from several potential suppliers and then choose one based on some criteria. From the EDI perspective, this process can involve exchanging seven or more different message types.

1. The first step is for the government agency to package a Request for Quote (RFQ) and send this RFQ (transaction set 840) out to a number of suppliers.

The RFQ will have a bid due date indicating when the quotes (bids) must be submitted by, shipping instructions for the materials to be provided and a number of line items with standardized part numbers.

2. A supplier that receives an RFQ may reply with a request for technical information about one or more of the line items on the RFQ.
3. The government agency will then furnish additional technical information to the supplier via transaction set 841.

The previous steps can be repeated several times if more technical information is required.

4. Each supplier will then prepare a bid based on some or all of the line items of the RFQ. This bid or "Response to RFQ" (transaction set 843) is sent to the government agency. It is possible to provide bids for only some of the items on the RFQ. Other variances such as delivery date and cost may also be noted on the bid.
5. After the bidding due date has passed, the agency will then make a decision to award the contract to one or more of the suppliers. It is not uncommon to award parts of the contract to different suppliers.

The suppliers that win awards will then be sent contract award notices (transaction set 836) followed by purchase orders (transaction set 850 as in the previous example).

6. Upon receipt of the purchase orders, the suppliers will immediately send back a purchase order acknowledgement (transaction set 855) to the government agency.

7. When the supplier is ready to ship the materials to the agency, they may send an advanced shipping notice (transaction set 856) which includes a manifest of the items on their way to the agency.
8. After the delivery, each supplier will then follow up with an invoice (transaction set 810) to facilitate payment for the delivered materials.

In terms of cost savings over a paper based scenario, note that each additional potential supplier in the above exchange equates to the following additional documentation:

- Initial RFQ to be sent out
- Technical specifications and other information to be sent out
- Bid to be received

This extensive exchange of messages is currently carried out using traditional paper and postal service methods. Performing the above scenario using EDI transactions represents a significant savings in the total lifecycle time as well as in the cost of preparing, sending and receiving the various documents.

The previous examples serve to illustrate both the complexity of the implementation details and the potential cost and time savings that are indicative of EDI implementations.

7 EDI Challenges

In this section, some of the many challenges, present and future, for developing an effective EDI implementations are discussed.

7.1 Compatibility

Information systems that use EDI may be incompatible in one or more of the following ways:

1. The databases or information systems used by each of the trading partners may differ significantly. For example, different terminology may be used when describing the various business forms and practices. The physical layout of data tables and data files may also differ.
2. EDI translation software differs. Different implementations of the same EDI standard by different software vendors can lead to some incompatibilities.

3. Value Added Network (VAN) providers differ. If trading partners subscribe to two different VANs, then they may not be able to exchange EDI messages.

One of the promises of EDI is to adapt to incompatibilities in basic information systems as in the first item above. Provided a common EDI standard is strictly adhered to, the particular vendors of EDI translation software should not pose a problem. Certain VAN providers can also supply gateways to other VAN services which can alleviate problems as noted in the third item above.

Using identical information systems, EDI standards, EDI translation software and VAN providers for all trading partners poses an ideal situation which is encountered in several industries. In its early years, EDI was first implemented by large manufacturers and shipping companies. In many cases, the size and purchasing power of these companies allowed them to dictate specific hardware and software combinations to their trading partners. This implementation technique alleviates a large part of the implementation problems attributed to incompatible systems.

Although this method works for large companies with relatively few suppliers, current trends indicate many more small businesses would also like to benefit from EDI. Small businesses may be less likely to dictate specific software and hardware systems to trading partners. This results in each trading partner implementing differing information systems that may lead to the incompatibility problems discussed.

Relationships with international trading partners heighten the compatibility requirements as international EDI standards such as EDIFACT must be followed. As with the compatibility issues discussed here, the compatibility challenges are strictly technical in the sense that firm standards followed precisely can alleviate many of the compatibility issues. Following these international standards will allow trading partners from around the world to do business using EDI.

7.2 U.S. Government Demands

Several governmental initiatives for implementing EDI have been put forth recently. Military procurement offices such as the Defense Logistics Agency (DLA) and the Defense Personnel Support Center (DPSC) have indicated a strong desire to perform most business transactions electronically. For large companies that may already have other EDI systems in place, working with the government can be treated like any other business relationship. For companies without EDI experience (especially small businesses), the added demands of the governmental EDI pose a major challenge.

Fortunately, the U.S. government is willing to provide assistance to small businesses that are interested in becoming EDI capable. The DoD and the DLA can provide a number of brochures and guides to implementing "governmental EDI" for small businesses (See for example [HH93]). The specific contacts for this information are given in Appendix III starting on page 43.

7.3 Small Business

The challenges of implementing EDI are made more apparent when small businesses are considered. A typical small business may not have an integrated database system in place that works with purchasing, billing and other areas of the company. Often, these functions are performed on personal computer spreadsheets or single user databases. Although some staff may be familiar with personal computers and some applications such as word processing and spreadsheets, EDI translation packages and VAN communications are typically more complex to learn and to administrate.

Choosing an EDI system and network provider is also more difficult due to the possible lack of employees that can be dedicated to the task. Lastly, the up front cost of EDI may also pose a barrier to small businesses. Initial start up costs for EDI may be difficult to justify especially when the payback period is long. Because a small business may not generate a large number of business transactions, the payback period may be considerably longer.

Small businesses, especially newly formed small businesses, have the advantage of business flexibility. Because EDI focuses on, and changes the way a company does business, small businesses are able to adapt quickly and take advantage of EDI benefits.

7.4 Trading Partner Agreements

Traditionally, EDI has worked best when trading partners extend their existing business relationships to include transactions made via EDI. In such cases, trading partner agreements (TPA) are created and adhered-to by both parties. A typical TPA might include the following information [GT94]:

- A list of business transactions to be exchanged
- Specific EDI standards to be followed (e.g. EDIFACT or X12)
- Contingency plans and liability statements in the event of transmission or EDI syntax errors

Since these relationships tend to be long term, TPAs are viable tools that can help to ensure the success of an EDI project. Typically a TPA will exist for each pair of trading partners. For a detailed example of an EDI Trading Partner Agreement, please refer to [Bak91] Appendix C.

However, under the more general umbrella of Electronic Commerce (EC), business relationships may be created and terminated within a very short period of time. It may be necessary to exchange EDI transactions between trading partners who have never been in contact before (and, hence no TPA would exist).

An example of such a relationship would be a customer who walks into a sporting goods store to purchase a pair of sneakers. The "business relationship" lasts no more than an hour and the transactions involve a very brief exchange of currency.

In order to accommodate such relationships in the EDI world, more general TPAs that are applicable to a wide range of business relationships need to be crafted.

References

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8 Appendix I - ANSI ASC X12 Transaction Sets

The ANSI ASC X12 standard has over ninety official transaction sets and many more draft specifications. Some of these transaction sets are described in the following tables in order of transaction set number. These tables contain transactions that are part of the ANSI ASC X12 version 3041 standard.

The middle column in each table has the following codes:

TBD To Be Deleted as of June, 1994

Ballot Currently being voted on for addition to X12 by the ASC as of June, 1994

Devel. Under Development as of June, 1994 but has not reached the voting stage

blank Currently in use

The tables are broken down by related areas for the transaction sets. New transactions are being developed at a steady pace so the contents of this table is subject to change.

Air Shipment Transactions		
Set Number	Code	Name and Use
101	TBD	Flight Confirmation
104		Air Shipment Information
105	TBD	Container/Equipment Transfer (Air)
107	TBD	Shipment Information for Export Declaration (Air)
108	TBD	Shipment Information for Import (Air)
109	TBD	Shipment Information for Pickup/Delivery Order
110		Air Freight Details and Invoice
111	TBD	Freight Details and Invoice Summary (Air)
113	TBD	Inquiry (Air)
115	TBD	Status Details Reply (Air)
116	TBD	Repetitive Pattern Maintenance
Ground Shipment Transactions		
Set Number	Code	Name and Use
120		Vehicle Shipping Order
121		Vehicle Service
125		Multilevel Railcar Load Details
126		Vehicle Application Advice
127		Vehicle Bidding Order
128		Dealer Information
129		Vehicle Carrier Rate Update
Student Information Transactions		
Set Number	Code	Name and Use
130		Student Educational Record (Transcript)
131		Student Educational Record (Transcript) Acknowledgment
135		Student Loan Application
139		Student Loan Guarantee Result

Set Number	Code	Name and Use
140		Product Registration
141		Product Service Claim Response
142		Product Service Claim
143		Product Service Notification
144		Student Loan Transfer and Status Verification
146		Request for Student Educational Record (Transcript)
147		Response to Request for Student Educational Record (Transcript)
148		Report of Injury or Illness
150		Tax Rate Notification
151		Electronic Filing of Tax Return Data Acknowledgment
152		Statistical Government Information
154		Uniform Commercial Code Filing
161		Train Sheet
170		Revenue Receipts Statement
175		Court Notice
176		Bankruptcy Proof of Claim
180		Return Merchandise Authorization and Notification
185	Ballot	Royalty Regulatory Reports
186		Laboratory Reporting
190		Student Enrollment Verification
191		Student Loan Preclaims
195	Ballot	FCC License Application
196		Contractor Cost Data Reporting
200	Ballot	Mortgage Credit Report
201	Ballot	Residential Loan Application
203	Ballot	Secondary Mortgage Market Investor Report
204		Motor Carrier Shipment Information
210		Motor Carrier Freight Details and Invoice
213		Motor Carrier Shipment Status Inquiry
214		Transportation Carrier Shipment Status Message
217		Motor Carrier Loading and Route Guide
218		Motor Carrier Tariff Information
250		Purchase Order Shipment Management Document
251		Pricing Support
257	Ballot	Health Care Eligibility/Benefit Inquiry Immediate Response
258	Ballot	Health Care Eligibility/Benefit Information Immediate Response
260		Application for Mortgage Insurance Benefits
263		Residential Mortgage Insurance Application Response
264		Mortgage Loan Default Status
265		Real Estate Title Insurance Services Order
266	Ballot	Mortgage Record Exchange
Healthcare Transactions		
Set Number	Code	Name and Use
270		Health Care Eligibility/Benefit Inquiry
271		Health Care Eligibility/Benefit Information
272		Property and Casualty Loss Notification
276		Health Care Claim Status Request
277		Health Care Claim Status Notification
278	Ballot	Health Care Service Review Information
279	Ballot	Health Care Service Review Request
290		Cooperative Advertising Agreements

Ocean Shipment Transactions		
Set Number	Code	Name and Use
300		Reservation (Booking Request) (Ocean)
301		Confirmation (Ocean)
302	TBD	Container/Specialized Equipment Pick-up Order
303		Booking Cancellation (Ocean)
304		Shipping Instructions (Ocean)
305	TBD	Container/Equipment Transfer (Ocean)
306		Dock Receipt
307	TBD	Shipment Information for Export Declaration (Ocean)
309		U.S. Customs Manifest
310		Freight Receipt and Invoice (Ocean)
311		Canadian Customs Information
312		Arrival Notice (Ocean)
313		Shipment Status Inquiry (Ocean)
314	TBD	Shipment Identities and Status Reply (Ocean)
315		Status Details (Ocean)
316	TBD	Repetitive Pattern Maintenance (Ocean)
317		Delivery/Pickup Order
319		Terminal Information
321		Demurrage Guarantee (Ocean)
322		Terminal Operations Activity (Ocean)
323		Vessel Schedule and Itinerary (Ocean)
324		Vessel Stow Plan (Ocean)
325		Consolidation of Goods In Container
326		Consignment Summary List
350		U.S. Customs Release Information
352		U.S. Customs Carrier General Order Status
353		U.S. Customs Events Advisory Details
354		U.S. Customs Automated Manifest Archive Status
355		U.S. Customs Manifest Acceptance/Rejection
356		U.S. Customs Permit To Transfer Request
357	Ballot	U.S. Customs In-Bond Information
358	Ballot	U.S. Customs Consist Information
360	TBD	Tariff Information (Ocean)
361		Carrier Interchange Agreement (Ocean)
362		Cargo Insurance Advice of Shipment

Rail Shipment Transactions		
Set Number	Code	Name and Use
402	Ballot	Waybill or Historical Rate Request
404		Rail Carrier Shipment Information
410		Rail Carrier Freight Details and Invoice
411		Freight Details and Invoice Summary
414		Rail Car hire Settlements
417		Rail Carrier Waybill Interchange
418		Rail Advance Interchange Consist
419		Advance Car Disposition
420		Car Handling Information
421		Estimated Time of Arrival and Car Scheduling
422		Shipper's Car Order
423	Ballot	Rail Industrial Switch List
424		Switch Bills
425		Rail Waybill Request
426		Rail Revenue Waybill
427	Ballot	Rail Waybill Response
429		Railroad Retirement Activity
431		Railroad Station Master File
432	Ballot	Rail Deprescription
433	Ballot	Railroad Reciprocal Switch File
435	Ballot	Standard Transportation Commodity Code Master
440		Shipment Weights
451	Ballot	Railroad Event Report
452	Ballot	Railroad Problem Log Inquiry or Advice
453	Ballot	Railroad Service Commitment Advice
455	Ballot	Railroad Parameter Trace Registration
456	Ballot	Railroad Equipment Inquiry or Advice
460		Rate Format Docket Data
461		Rate Format Level Data
462		Rate Format Sub-Level Data
463	Ballot	Rate Rail Reply
464		Rate Set Docket Data
465		Rate Set Sub-Level Data
466		Rate Request
467		Scale Rate Docket Transmittal
468		Rate Docket Journal Log
469		Rate Distribution Set
475		Rail Route File Maintenance
480		Docket/Cluster Terminator
485		Ratemaking Action
486	Ballot	Rate Docket Expiration
490		Rate Group Definition
491		Rate Increase/Decrease Transmittal
492		Miscellaneous Rates
493	Devel.	Rate Docket Data, Part 1
494		Scale Rate Table
499		Application Acceptance Rejection Advice

Set Number	Code	Name and Use
511		Requisition
517		Material Obligation Validation
527		Material Due-In and Receipt
536		Logistics Reassignment
561		Contract Abstract
567		Contract Completion Status
568		Contract Payment Management Report
601		Shipper's Export Declaration
602		Transportation Services Tender
622		Intermodal Ramp Activity
715	Ballot	Group Loading Plan

Set Number	Code	Name and Use
805		Contract Pricing Proposal
806		Project Schedule Reporting
810		Invoice
811		Consolidated Service Invoice/Statement
812		Credit/Debit Adjustment
813		Electronic Filing of Tax Return Data
815		Cryptographic Service Message
816		Organizational Relationships
818		Commission Sales Report
819		Operating Expense Statement

Set Number	Code	Name and Use
820		Payment Order/Remittance Advice
821		Financial Information Reporting
822		Customer Account Analysis
823		Lockbox
824		Application Advice
826		Tax Information Reporting
827		Financial Return Notice
828		Debit Authorization
829		Payment Cancellation Request
830		Planning Schedule with Release Capability
831		Application Control Totals
832		Price/Sales Catalog
833		Residential Mortgage Credit Report Order
834		Benefit Enrollment and Maintenance
835		Health Care Claim Payment/Advice
836		Contract Award
837		Health Care Claim
838		Trading Partner Profile
839		Project Cost Reporting
840		Request for Quotation
841		Specifications/Technical Information
842		Nonconformance Report
843		Response to Request for Quotation
844		Product Transfer Account Adjustment
845		Price Authorization Acknowledgment/Status
846		Inventory Inquiry/Advice
847		Material Claim
848		Material Safety Data Sheet
849		Response to Product Transfer Account Adjustment

Set Number	Code	Name and Use
850		Purchase Order
851		Asset Schedule
852		Product Activity Data
853		Routing and Carrier Instruction
854		Shipment Delivery Discrepancy Information
855		Purchase Order Acknowledgment
856		Ship Notice/Manifest
857		Shipment and Billing Notice
858		Shipment Information
859		Freight Invoice
860		Purchase Order Change Request and Buyer Initiated
861		Receiving Advice/Acceptance Certificate
862		Shipping Schedule
863		Report of Test Results
864		Text Message
865		Purchase Order Change Acknowledgment/Request and Seller Initiated
866		Production Sequence
867		Product Transfer and Resale Report
868		Electronic Form Structure
869		Order Status Inquiry
870		Order Status Report
872		Residential Mortgage Insurance Application
874	TBD	Purchase Order - Multipoint
875		Grocery Products Purchase Order
876		Grocery Products Purchase Order Change
877	TBD	Purchase Order Adjustment (UCS)
878		Product Authorization/Deauthorization
879		Price Change

Set Number	Code	Name and Use
880		Grocery Products Invoice
881	TBD	Credit Memo/Debit Memo
882		Direct Store Delivery Summary Information
883		Market Development Fund Allocation
884		Market Development Fund Settlement
885	Ballot	Store Characteristics
886	Ballot	Customer Call Reporting
888		Item Maintenance
889		Promotion Announcement
890	TBD	Payment Adjustment Advice (UCS)
891	Ballot	Deduction Research Report
892	TBD	Promotion Announcement Confirmation
893		Item Information Request
894		Delivery/Return Base Record
895		Delivery/Return Acknowledgment or Adjustment
896		Product Dimension Maintenance

Management Transactions		
Set Number	Code	Name and Use
905	TBD	Remittance Advice (UCS)
920		Loss or Damage Claim and General Commodities
924		Loss or Damage Claim and Motor Vehicle
925		Claim Tracer
926		Claim Status Report and Tracer Reply
928		Automotive Inspection Detail
940		Warehouse Shipping Order
941	TBD	Warehouse Inventory Status Report
942	TBD	Warehouse Activity Report
943		Warehouse Stock Transfer Shipment Advice
944		Warehouse Stock Transfer Receipt Advice
945		Warehouse Shipping Advice
946		Delivery Information Message
947		Warehouse Inventory Adjustment Advice
980		Functional Group Totals
990		Response to a Load Tender
994		Administrative Message
995	TBD	Advisory Information
996		File Transfer
997		Functional Acknowledgment
998		Set Cancellation
999		Acceptance/Rejection Advice

9 Appendix II - EDIFACT Transaction Sets

The international EDIFACT standards has similar but not identical standards sets when compared to the ASC X12 transactions. Some of the EDIFACT standards currently in use in version D93.A are given in the following table:

Set Id	Name and Use
BANSTA	Banking Status Message
BAPLIE	Bayplan/Stowage Plan Occupied and Empty Locations
BAPLTE	Bayplan/Stowage Plan Total Numbers Message
CONDPV	Direct Payment Valuation Message
CONEST	Establishment of Contract
CONITT	Invitation to Tender Message
CONPVA	Payment Valuation Message
CONQVA	Quality Validation Message
CONTEN	Tender Message
CREADV	Credit Advice Message
CREEXT	Extended Credit Advice Message
CUSCAR	Customs Cargo Report Message
CUSDEC	Customs Declaration Message
CUSREP	Customs Conveyance Report Message
CUSRES	Customs Response Message
DEBADV	Debit Advice Message
DELFOR	Delivery Schedule Message
DELJIT	Just In Time Message
DESADV	Despatch Advice Message
DIRDEB	Direct Debit Message
DOCADV	Documentary Credit Advice Message
DOCAPP	Documentary Credit Application Message
DOCINF	Documentary Credit Issuance Information Message
IFCSUM	Forwarding and Consolidation Summary Message
IFTCCA	Forwarding and transport shipment charge calculation msg.
IFTMAN	Arrival Notice Message
IFTMBC	Booking Confirmation Message
IFTMBF	Firm Booking Message
IFTMBP	Provisional Booking Message
IFTMCS	Instruction Contract Status Message
IFTMIN	Instruction Message
IFTRIN	Forwarding and transport rate information message
IFTSAI	Forwarding and transport schedule and availability information message
IFTSTA	International Multimodal Status Report Message
INVOIC	Invoice Message
INVRPT	Inventory Report Message
ORDCHG	Purchase Order Change Request Message
ORDERS	Purchase Order Message
ORDRSP	Purchase Order Response Message
PARTIN	Party Information Message
PAXLST	Passenger List Message
PAYDUC	Payroll Deductions Advice Message
PAYEXT	Extended Payment Order Message
PAYMUL	Multiple Payment Order Message
PAYORD	Payment Order Message
PRICAT	Price/Sales Catalogue Message
QALITY	Quality Data Message
QUOTES	Quote Message
REMADV	Remittance Advice Message
REQOTE	Request For Quote Message
SANCRT	Sanitary/phytosanitary Certificate
SLSRPT	Sales Data Report Message
STATAC	Statement Of Account Message
SUPCOT	Superannuation Contributions Advice Message
SUPMAN	Superannuation Maintenance Message

10 Appendix III - EDI Resources Directory

The EDI industry is filled with various standards bodies and agencies that can offer assistance to companies who are interested in using EDI. In particular, the U.S. Department of Defense (DoD) and the Defense Logistics Agency (DLA) are more than willing to help businesses become EDI capable. Some of the major contacts for EDI information are given in this section.

The Universal Resource Locator (URL) convention is used for FTP and World Wide Web sites on the Internet.

- **ANSI ASC X12 standards information**

ASC X12 Secretariat
Data Interchange Standards Association
1800 Diagonal Road, Suite 355
Alexandria, Virginia 22314-2852
Phone: (703) 548-7005

- **EDIFACT standards information**

Gaile Spadin
Data Interchange Standards Association
1800 Diagonal Road, Suite 355
Alexandria, Virginia 22314-2852
Phone: (703) 548-7005

- **Publishers of the ANSI ASC X12 standards**

Data Interchange Standards Association (DISA)

- **Information on using EDI with the DoD and DLA**

U.S. Department of Defense (DoD)
Logistics Management Institute
2000 Corporate Ridge
McLean, Virginia 22102-7805
E-mail: library@lmi.org

Defense Information Systems Agency
Center for Standards
ATTN: TBCB-EC/EDI
10701 Parkridge Boulevard
Reston, Virginia 22091-4398
E-mail: edi@jcdbs.itsi.disa.mil

URL: <ftp://ftp.sterling.com/edi/DoD-edi/>

Electronic Commerce Coordinator
Defense Personnel Support Center (DPSC)
DPSC-HIE 2800 South 20th Street
Philadelphia, Pennsylvania 19101-8419
Phone: (215) 737-2987

Call the National Technical Information Service (NTIS) for a catalog of EDI related publications available from the DoD. Phone: (703) 487-4650.

- **Information on Electronic Commerce (EC)**

National Institute of Standards and Technology
Gaithersburg, Maryland 20899

- **Information on Product Data Exchange**

Initiative for Product Data Exchange Office
National Institute of Standards and Technology
Building 245, Room B102
Gaithersburg, Maryland 20899
Phone: (301) 975-3986
Fax: (301) 926-8730

- **On-Line Papers on EDI**

URL: <ftp://ftp.sterling.com/edi>

- **On-Line Information on EDI Standards**

URL: <http://www.premenos.com>

11 Glossary

ACH	Automated Clearing House
AIAG	Automotive Industry Action Group
ANSI	American National Standards Institute
ASC	Accredited Standards Committee
ASCII	American Standard Code for Information Interchange
BBS	Bulletin Board Service
CAD	Computer Aided Design
CAE	Computer Aided Engineering
CAM	Computer Aided Manufacturing
CIM	Computer Integrated Manufacturing
DISA	Data Interchange Standards Association
DLA	Defense Logistics Agency
DoD	Department of Defense
DPSC	Defense Personnel Support Center
EC	Electronic Commerce
EDI	Electronic Data Interchange
EDIA	Electronic Data Interchange Association
EDIFACT	Electronic Data Interchange for Administration, Commerce and Transport
EFTA	European Free Trade Association
EFT	Electronic Funds Transfer
E-Mail	Electronic Mail
ERS	Evaluated Receipt Settlement
FAR	Federal Acquisition Regulation
FIPS	Federal Information Processing Standards
FMS	Financial Management Service
FRB	Federal Reserve Bank
IETF	Internet Engineering Task Force
IGES	Initial Graphics Exchange Specification
IOC	Initial Operational Capability
IOS	Inter-Organizational Information Systems
ISO	International Standards Organization
JIT	Just In Time
MIME	Multipurpose Internet Mail Extensions
MTA	Message Transfer Agent
NII	National Information Infrastructure
NIST	National Institute of Standards and Technology
NTE	Note segment of an EDI message
OLDB	On Line DataBase
PC	Personal Computer
PDE	Product Data Exchange
PDES	Product Data Exchange using STEP
PO	Purchase Order
RDA	Remote Database Access
RFC	Request For Comment
RFP	Request For Proposal
RFQ	Request For Quotation
SBA	Small Business Administration
SF	Standard Form
SGML	Standard Generalized Mark-up Language
SNA	Systems Network Architecture
STEP	Standard for The Exchange of Product Model Data

TDCC	Transportation Data Coordinating Committee
TDED	UNECE Trade Data Elements Directory
TDID	Trade Data Interchange Directory
TEDIS	Trade Electronic Data Interchange Systems
TPA	Trading Partner Agreement
TQM	Total Quality Management
TS	Transaction Set
TSDS	Transaction Set Development System
UN-EDIFACT	International EDI standards committee
UN/ECE	United Nations Economic Commission for Europe
VAN	Value Added Network
VAS	Value Added Service
X12	ANSI ASC sub-committee charged with defining U.S. EDI standards.

**COMBAT RATION
ADVANCED MANUFACTURING
TECHNOLOGY DEMONSTRATION
(CRAMTD)**

**Electronic Data Interchange:
EDI Translation Software Evaluation**

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Contents

1	Introduction	3
2	Overview of EDI	3
2.1	EDI Benefits to Business	4
2.2	EDI Standards	5
2.3	EDI Basic Components	5
3	EDI Translation Software Features	6
3.1	Basic Features	7
3.2	Additional Features	9
4	Evaluation Criteria	10
4.1	Technical Criteria	10
4.2	Nontechnical Criteria	14
4.3	Weighting the Criteria	16
5	Evaluation Procedure	18
6	Conclusions	22
7	Glossary	24

List of Figures

1	Flow of Data showing EDI Components	6
2	Technical Criteria Hierarchy with Weights	17
3	Nontechnical Criteria Hierarchy with Weights	17
4	Nontechnical Criteria Hierarchy with Scores for Two EDI Translators	20

1 Introduction

Several software and hardware components are required to facilitate Electronic Data Interchange (EDI) of standard business transactions. *EDI Translation Software* plays the role of a universal interpreter between two businesses or trading partners by ensuring that a common standard is followed for the format of an EDI message. By adhering to a common standard, businesses can fully realize the benefits of EDI.

The software market for EDI translators is small in comparison to other packages such as word processing or spreadsheets, however, it is often more difficult to compare translation software due to the overall complexity and large feature sets of the packages. EDI Translators are usually integrated with existing company databases rather than used in isolation. This makes comparisons even more difficult as the *integration* of EDI translators becomes a major issue.

The objectives of this paper are to:

1. Give a brief overview of EDI;
2. Describe a set of *basic features* that all EDI translators should possess;
3. Describe a set of *additional features* that are desirable in an EDI translator;
4. Introduce a collection of *technical* and *nontechnical* criteria for evaluating EDI translators;
5. Develop a *structured tool* for evaluating EDI translation software; and
6. Present an evaluation *procedure* for EDI translation software that uses the structured evaluation tool.

2 Overview of EDI

¹ All over the world, companies conduct business by exchanging documents such as orders, contracts, catalogs and payments. With the advent of computers and information systems, many companies store data about these business transactions. However, the data entry function associated with the exchange of business documents is costly in terms of time and data entry errors. These shortcomings, coupled with the inherent latency of the exchange of paper business documents lead to the creation of Electronic Data Interchange.

Although most individuals agree on the basic concepts behind EDI, there have been many definitions put forth to describe it. See, for example [Dat93], [Coa88], [Emm90], [GT94], [HH93] and [AEHJ95]. The essential features of EDI are:

¹For an in-depth treatment of EDI concepts with examples, please refer to [AEHJ95].

- Business transactions have some commonality across businesses and across industries.
- Business transactions can be standardized. For example, the purpose and contents of a purchase order can be agreed upon by most businesses.
- Processing of standardized transactions can be automated.

2.1 EDI Benefits to Business

The use of EDI can benefit a business in many ways. All of the following benefits of using EDI lead to cost savings either directly or indirectly through fewer man-hour requirements (summarized from [SS92], [Dat93] and [HH93]).

- Using EDI shortens the processing time for incoming and outgoing business documents.
- Using EDI reduces requirements for paper, printing supplies and postage.
- Using EDI reduces requirements for the number of data processing and clerical staff such as order entry personnel.
- Using EDI increases the quality of the data in information systems. Data entry errors are eliminated.
- Using EDI can allow for lower inventory levels to be maintained since ordering cycles are much shorter.

The quantifiable benefits listed above may lead to the following benefits for an organization that adopts EDI.

- Better customer response [SS92]. Customers can receive better quality information such as order or delivery status.
- Uniform communications with all trading partners [Dat93]. Fewer but more robust avenues of communication may simplify communications. For example, the U.S. Department of Defense (DoD) has made steps to move to completely automated bidding and contract negotiation systems using EDI [HH93].
- Increased business opportunities. When dealing with government contracts, Requests for Quotations (RFQs) are frequently distributed to potential suppliers. Receiving RFQs electronically via EDI can allow a supplier to evaluate more RFQs and to generate bids in response [HH93].

2.2 EDI Standards

In 1979 the American National Standards Institute (ANSI) began developing the ASC X12 standards for EDI. At the same time, with the emergence of many multi-national companies and with the growing global economy, there was a pressing need for international standards. In 1985 the United Nations began developing the EDIFACT standards for international trade. Both sets of standards describe the actual format of EDI transactions that, if adhered to, can allow trading partners to exchange business documents.

Each EDI standard (X12 and EDIFACT) are comprised of a series of *transaction sets* that are used for specific business transactions. The following are examples from the ANSI X12 standard:

Transaction Set	Name and Use
810	Invoice
820	Payment Order/Remittance Advice
840	Request for Quotation
843	Response to Request for Quotation
850	Purchase Order
855	Purchase Order Acknowledgment
856	Ship Notice/Manifest

Over time, some transaction sets are improved and expanded upon. When improvements are made, a new transaction set *version* is released. For example, the ANSI X12 transaction set 850 - Purchase Order has been updated from versions 3010, 3020, 3030 and now is currently at version 3040.

2.3 EDI Basic Components

EDI requires many basic components that work together to extract, package and transmit EDI messages. In some systems, the functionality of these components is combined in one subsystem. This section is intended to give an overview of the basic software components required to perform EDI transactions. Many businesses will already have some of the software components, such as a database, already in place. Other software components must be purchased from commercial sources or written by the organization's MIS or computer programming staff.

Figure 1 gives a general outline of the flow of data through an EDI system between two trading partners. In the figure, both trading partners have databases that are used to store information about business transactions. These databases will generally not resemble each other. By using the appropriate Extract utility, data for the business transaction can be extracted to an ASCII file (a procedure known as Mapping) which is then converted to an EDI Transaction using the EDI translation software. The final step from the originating side is to upload the EDI transaction to a Value Added

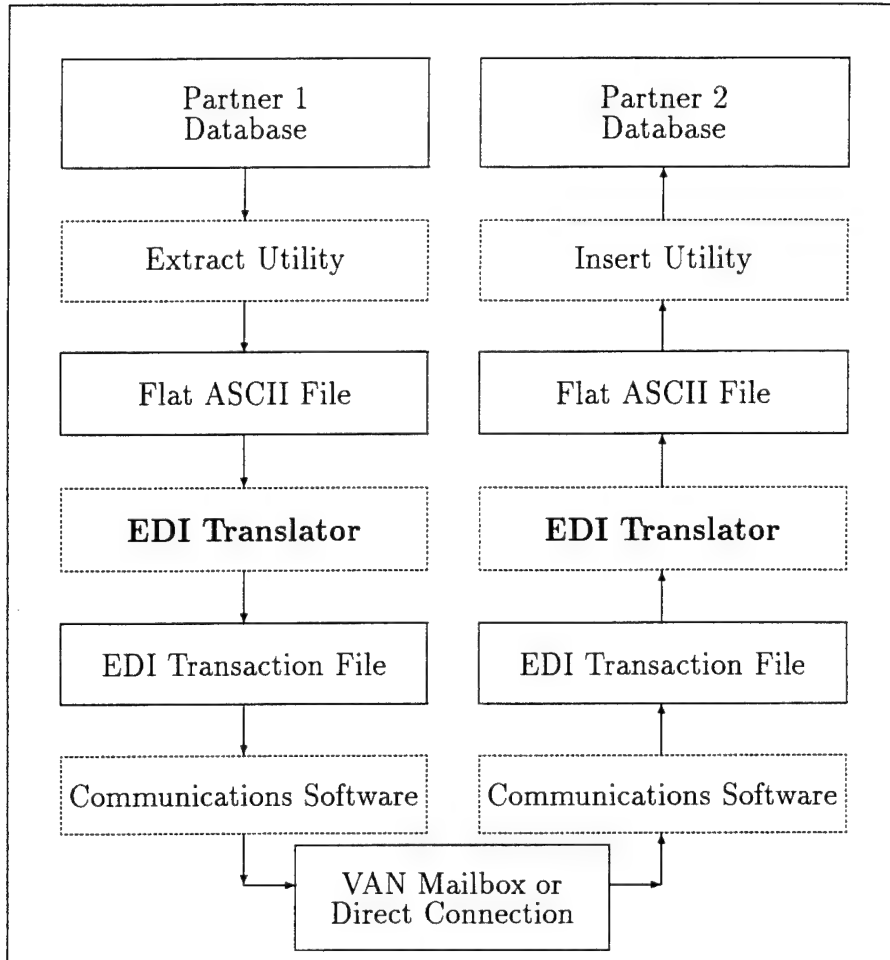


Figure 1: Flow of Data showing EDI Components

Network (VAN) or directly to the trading partner. The procedure is reversed on the receiving end.

3 EDI Translation Software Features

This section will describe the basic features most, if not all, reasonable EDI translation software possess and some additional features that are desirable in EDI translation software. Most of these features can be determined by reading the product literature or by contacting a sales representative from the software vendor.

Each EDI translation software package may possess these features to varying degrees. For example a particular package may only support a few of the ANSI X12 transaction sets. The *degree* to which an EDI translation software package supports

these features is addressed in the *technical* and *nontechnical* criteria for evaluating EDI translators in section 4 starting on page 10.

Often, when companies first begin investigating EDI, a simple question is asked: "Which EDI software should we buy?" To which the typical answer is: "Buy the software that meets your needs". To determine exactly what are the "needs" of an organization, each feature outlined below includes some indication of why the feature is important and how this can aid in meeting the needs of the organization.

3.1 Basic Features

A basic feature is one that is necessary to provide a rudimentary level of EDI use.

- **Support for ANSI X12 and/or EDIFACT standards**

EDI translation software must understand either one or both of these standards in order to exchange transactions. For businesses new to EDI, the EDI standard in use by the potential trading partners will be an important factor. Typically, within the U.S., the ANSI X12 standard is used whereas the EDIFACT standard is used more heavily in other countries.

Some EDI translator software vendors charge a fee for each transaction set to be used. For example, if only Purchase Orders and Invoices (transaction sets 850 and 810) will be exchanged via EDI, then only those transaction sets would be purchased.

- **Updatable Transaction Sets**

As new *versions* of EDI standards are released, it is important that the translation software be easily upgradable to accommodate them. Translators that implement EDI standards which can not be upgraded or are prohibitively expensive to upgrade represent a less attractive solution.

- **Reporting**

In automated EDI systems, orders, invoices and other business transactions can be processed automatically without human intervention. Some mechanisms are required to alert personnel when any errors occur in the format of an EDI transaction or during the transmission of the EDI transaction. Reporting capabilities enable the EDI translator to print *exception reports* when problems occur and *summary reports* of daily, weekly or monthly EDI activity.

Several EDI translators offer customized reporting capabilities that allow the user to create reports that are tailored to the needs of the organization.

- **Computer Hardware and Operating system support**

EDI translators run on a wide variety of computer hardware and operating system platforms. A heavy volume (over 200 transactions per day) of EDI

transactions requires more powerful computing support such as minicomputers, workstations or mainframes. For a lower volume of transactions, either stand alone personal computers (PC) or a Local Area Network (LAN) of PCs may suffice.

EDI translator software may run on more than one platform while maintaining compatibility. Such software offers an upgrade path that can start small to meet immediate needs but can also scale up to meet potentially heavy volumes of EDI transactions.

- **Security**

Many EDI transactions deal with potentially sensitive data such as Purchase Orders, Invoices and Quotations. Most EDI translator packages have some security mechanisms in place to prevent unauthorized access to data and to information about trading partners.

If the transactions exchanged with trading partners are sensitive, then security issues at all levels (not just at the EDI translator) should be addressed.

- **Documentation**

All EDI software should be provided with complete and clear documentation that can inform a user as to how to install and customize the EDI translation software to suit the organization. Good quality documentation is of great importance when integrating EDI translation software with other components of an EDI system such as databases and communications software.

Installation guides give step by step instructions for installing the basic translation software. Tutorials teach the new user how to work with the software to customize it for specific trading partners. Reference guides contain complete listings and definitions of all commands and features of the software.

- **Technical Support**

Documentation can only go so far when troubleshooting EDI systems. Often it is necessary to contact the software vendor for advice on configuring the software and to report bugs or other problems.

The responsiveness and availability of technical support plays a large role in the relationship between a business and the software vendor. Some software vendors charge an additional fee for technical support while others may only allow free technical support for a limited time period. Note also, the time of day when technical support is available especially if the software vendor is located several time zones away.

3.2 Additional Features

- **Built in database**

Many EDI translators come with a small built in database that can be used to enter data to be converted into EDI transactions. For small businesses that do not have an existing database, this can be an attractive alternative.

Note, however, that such databases are typically not very flexible and may only contain rudimentary data entry screens to facilitate entering new data for EDI transactions.

- **Data Mapping**

EDI translators require some form of input file that is then converted into an EDI transaction. If the original data resides in a corporate database, *Mapping* software must be used to map data elements in the database to the appropriate EDI transaction components.

Many EDI translators have mapping capability built into them while other software vendors provide mapping software separately. Some stand alone PC implementations also include a built in database and mapping software to form a self-contained system.

The need for mapping software depends on the means of storage for the original business data.

- **Communications Capabilities**

EDI transactions are typically sent either directly from one trading partner to another or via a Value Added Network (VAN) (See Figure 1). Communications software is responsible for sending and receiving EDI transactions from a trading partner or VAN.

As with mapping software, communications capabilities are often built in to the EDI translator software. This arrangement enables one software package to translate and then send off an EDI transaction.

- **Scheduling**

A scheduler is a piece of software that can trigger the execution of a task at specified times. EDI translation software may incorporate a scheduler to perform some translation routines at a specific time each day. For example, one might set the scheduler to automatically download any new EDI transactions, translate them into flat files and then insert them into the company database. This series of events might be scheduled to run at 10:00am and 2:00pm on each business day.

- **Training and Consulting services**

Many EDI software vendors offer on-site training and consulting services to help businesses new to EDI get up to speed on the software and hardware. Such services normally come at an additional price and may vary considerably between software vendors.

4 Evaluation Criteria

In section 3, some features of EDI translation software were introduced. These features can be used as a basis when comparing software from different vendors. Along the same lines, we may view the features of an EDI translator as the *criteria* for evaluation.

The evaluation criteria can be divided into two groups: *Technical criteria* that relate to the technical specifications of the software and *Nontechnical criteria* that relate to the software vendors themselves. The following sections will introduce the technical and nontechnical criteria. A third section will then discuss a method for assigning weights to all of the criteria in preparation for evaluation.

4.1 Technical Criteria

Technical criteria relates to the specifications of the EDI translation software. Successful EDI implementations depend on the degree to which the technical criteria for the EDI translation software are met. For example, if an EDI translator only supports the ANSI X12 standard transactions, then the software would not be appropriate for projects involving international trade.

- **Standards Support and Compliance**

EDI translation software may support one or more EDI transaction standards including ANSI X12, EDIFACT or other proprietary standards. Standards *compliance* deals with the how closely the software implementation follows a given standard. When new versions of standards are released, it is also important to know what the software vendor's policy is towards upgrading the software to meet the new standards.

The important issues to consider are whether or not the software supports the standards required by the trading partners, the quality of the implementation of those standards and the ability to update the software as standards are revised.

The cost of providing support for various transaction sets is addressed in the Nontechnical Criteria section starting on page 14.

- **Processing Architecture**

EDI translation software can be used as a *stand-alone* application or it can be used in conjunction with existing information systems. The latter case is known as an *integrated* EDI system.

Stand-alone translators will typically have a limited built in database as described in section 3. This facilitates small scale EDI transaction flow of perhaps a few transactions per day. This solution is suitable for companies with a low volume of business transactions and works especially well when no existing database systems are in use.

Integrated EDI systems require more work to install and attach to existing information systems. The payoff for this work is completely automated EDI capabilities that can process a high volume of EDI transactions without human intervention.

The main issue for processing architecture is matching the type of EDI system with the transaction volume and existing information systems of the company. EDI translators that can operate in both stand-alone and integrated modes are the best choices.

- **Hardware and Operating System Support**

The EDI translation software should run on the computer hardware platform and in conjunction with the operating system employed by the organization. If existing computers are to be used, the EDI software vendor should be able to supply a fully supported version that can run reliably. If the goal is to eventually upgrade to a new computer platform (e.g. from a personal computer to a UNIX workstation), the EDI translation software should be available for both platforms.

As with processing architecture, the volume of business transactions conducted with EDI will typically determine the type of computer hardware required.

The main issues for computer hardware and operating systems support are the availability of software on the platform of choice and the ability to scale up to more powerful systems without losing the initial investment.

- **Communications**

This criteria refers to the built in or additional support the EDI translator has for transmitting and receiving EDI transactions from a Value Added Network (VAN) or directly from a trading partner (See Figure 1). Some EDI translators have communications support built in to the basic product leaving only hardware (such as a modem) to be added.

Since there are many different VAN services available, as well as the option to connect directly with a trading partner, the ability to customize the communications software and support for a wide range of telecommunications hardware are the main issues.

- **Security**

To protect against unauthorized use of the EDI translator, security mechanisms should be available. Many systems incorporate simple username and password protection for the entire software package. Others allow protection at a finer level by enabling or disabling system functions depending on the current user. The latter methods are more difficult to set up initially but offer the finer control over accessing the translation software.

The main issues for security are the availability and ease of which mechanisms to prevent unauthorized access can be implemented.

- **Documentation**

Clear, concise and complete documentation is an invaluable resource when installing and learning to use EDI translation software. Separate installation guides, reference guides and tutorials offer the widest range of help for new users.

Installation guides should offer quick steps for getting up and running quickly while including detailed instructions for customizing the software and integrating it with additional programs such as communications and mapping software.

Reference guides should contain complete explanations of all of the software's functions and would ideally include references to the relevant EDI standards documents.

Tutorials can give the novice user documented examples for configuring and using the translation software. These examples can then be extended or used as a basis for setting up the translator to work with "real" trading partners.

- **User Interface**

The user interface refers to the parts of the EDI translation software the end-user works with. Some common user interfaces include a *command line*, *menus* and *graphical user interface* or GUI.

A command line interface requires the user to type in commands in order to make the software perform various functions. For example, to obtain help on performing a "Status" function, a user might type:

HELP STATUS

A menu driven interface allows the user to select commands from a list. Obtaining help on the above function would be as easy as selecting the HELP menu item.

A GUI allows the user to perform functions by manipulating objects on screen with a pointing device such as mouse. GUIs are fast becoming the standard user interface for software in all industries. For example, to obtain help on a function, the user may point to a HELP button on the screen.

Each style of interface can be nicely or poorly implemented. It is possible that a bad GUI is more difficult to use than a well designed menu system.

Some user interfaces are *customizable* to suit the needs of individuals. For example, additional menu items might be added to perform some functions defined by the user.

The main issues for user interface are whether or not the particular user interface makes the software easy to use and if it is customizable.

- **Scheduler**

A scheduler can help automate various EDI related tasks by automatically running the communications software, translator and insert/extract utilities at pre-set times during the day.

Some schedulers allow any task to be scheduled while others can only schedule one or two tasks. The flexibility in setting the timing is also important. For example, a company may wish to download and new purchase orders from a VAN at 10:00am on Monday through Friday but not on the weekends.

The main issues for schedulers are the ability to automate both EDI tasks and user defined tasks and the flexibility for setting execution times.

- **Reporting**

Reporting functions are used to produce *exception reports* when there are errors in transmission or errors in the translation process and to produce *usage reports* that indicate which transactions have been processed.

Error or exception reports are a basic requirement for automated EDI systems. Without such reports, the business has no idea which transactions are being processed and which are not. Usage reports may also be required for reconciliation with accounting records should a discrepancy occur. Some EDI translator packages may also offer customized reporting features.

The important issues to consider are whether or not the EDI translation software supports the types of reports the business requires and if the reports can be customized.

- **Error Handling**

Aside from printing an exception report, the handling of translation errors is a very important part of EDI translation software. Errors in translation may be attributed to data transmission errors that may garble parts of the transaction. Errors may also be attributed to non-conformance to EDI standards at the source of the transaction. If one trading partner is using software that incorrectly translates EDI transactions (due to a software bug or non-conformance to EDI standards), all other trading partners will have problems reading the transactions.

Some errors are correctable at the receiving end and can allow a transaction to pass through and be accepted. For example, a transaction may not conform to the latest version of an EDI standard. The receiving translator might recognize this and perform the translation using the older version of the standard. If errors in a transaction can't be corrected, both trading partners must be alerted either via additional EDI messages (in this case a negative confirmation) or via exception reporting.

Error handling issues include the ability to check for conformance to EDI standards, the means for correcting errors or the means by which trading partners are alerted to any problems.

4.2 Nontechnical Criteria

Nontechnical criteria relates to the specific attributes of the software vendor that supplies the software. These include the viability of the vendor in the EDI translation software market, the cost for software and accessories and other factors such as technical support and consulting services.

- **Software Costs**

The cost of EDI translation software can vary widely depending on the features of the software and the pricing policies of the software vendor. As a general framework for costs, the following cost breakdown is suggested:

- *Translation Engine* - The translation engine is the software that performs the actual translation. This core component is required for all EDI translation software systems and is often priced separately.
- *EDI Transaction Sets* - Each transaction set (e.g. 850 - Purchase Order) may be an additional cost. Also, new versions of transaction sets (e.g. 3030, 3040) may be an additional cost.

Some software vendors bundle all of the ANSI transaction sets or all of the EDIFACT transaction sets as part of the Translation Engine for one price. For companies that require many different transaction sets, this is an attractive alternative.

- *Communications* - Some EDI translation packages have built in communications programs that allow EDI transactions to be uploaded and downloaded directly into the translator. Most offer communications as a software program that must be purchased separately.
- *Mapping* - EDI translation software that offers an *integrated* processing architecture will often include a mapping component to aid in integrating the translation software with existing information systems. If this capability is not built in to the translation engine, then it may not be available or it may be available at an additional cost.

- *Scheduler* - Most EDI translators include a scheduling function to run the translation and communications tasks at particular times. If these features are not included, they can be purchased from other sources.
- *Maintenance* - Most EDI translation software vendors offer a yearly maintenance plan where any feature enhancements that are made on the software product (upgrades) can be obtained. The maintenance charge is typically a small fee that is much cheaper than outright purchasing a new version. Upgrades that fix bugs in the vendor's software should never carry an additional charge.

• Technical Support

Technical support is offered by the EDI translation software vendor to aid in installing, configuring and troubleshooting the software. Fees for this service range from free to *support plans* that charge a certain percentage of the total software cost each year technical support is requested.

The quality of technical support does not lend itself easily to quantitative measure, however, the following factors may be considered:

- The hours of operation for technical support. This is especially important if the vendor is several time zones away.
- The familiarity of the technical support staff with a wide variety of EDI installations and with their company's products.
- Any extra charges that are associated with technical support. These could include the cost of a toll call or a per minute or per incident charge.

As with vendors of word processing, spreadsheet and other application software, the trend seems to be to offer free technical support for a limited time (i.e. 90 days after purchase) while the software is setup and configured. The vast majority of problems requiring troubleshooting occur during this time.

• Vendor Attributes

As with any other significant purchase (e.g. a stereo, refrigerator, automobile, etc.) where a long term commitment to the product is required, concern for the position of the vendor in the respective market and for the overall health of the vendor become issues.

The following are criteria that reflect these concerns:

- *Market Share* - Is the vendor a market leader in number of sales or successful installations ?
- *Years in Business* - How long has the vendor been in business ?

- *Innovations* - Does the vendor have the capabilities to provide innovative solutions that benefit the industry ?
- *Experience* - How much experience does the vendor have in a particular industry (e.g. food manufacturing or ocean shipping) ?

4.3 Weighting the Criteria

Each of the technical and nontechnical criteria described in sections 4.1 and 4.2, vary in importance to each perspective buyer of EDI translation software. To account for this variation, each of the criteria can be assigned a weight factor representative of its importance.

For example, if the goal is to purchase the best EDI software available regardless of cost, then technical criteria such as **Standards Support, Reporting and User Interface** would have higher weights than nontechnical criteria such as **Software Costs**. Typically, the overall goal is to acquire EDI translation software that meets the business' needs, with the most features, for the least cost.

The criteria can be broken down to form a hierarchy as follows. Within technical criteria, each of the factors (e.g. Standards Support, Reporting, User Interface, etc.) are given weights that sum to **1.00**. Within nontechnical criteria, each of the factors (e.g. Software Costs, Technical Support, etc.) are assigned weights that also total to **1.00**.

Continuing further, within the nontechnical criteria of **Software Costs**, each of the sub-criteria (e.g. Translation Engine, Transaction Sets, Communications, etc.) are weighted such the total weight within **Software Costs** equals **1.00**. All of the criteria and sub-criteria are broken down in a similar fashion.

Note that some criteria may not be applicable or relevant to a given business. In this case, the criteria can be given a weighting of **0.00** or simply removed from the hierarchy. For example, if a business will only be exchanging business transactions with companies in Europe, then support for ANSI X12 transactions should not be a consideration.

By assigning weights in this fashion, it becomes easy to change the emphasis at any level to reflect the requirements of the business performing the evaluation. A sample criteria hierarchy for technical and nontechnical criteria can be seen in Figures 2 and 3 respectively.

In this section, the criteria for the evaluation of EDI translation software were described along with a hierarchical structure for weighting the criteria to emphasize the importance of some criteria over others. Once these criteria are agreed upon, the tables can be used as a tool to evaluate EDI translation software packages and vendors and to compare the various packages available on the market today.

Technical Criteria	Hierarchy Level	Weight
Standards Support and Compliance	1	0.2
X12 and/or EDIFACT	2	0.5
Version Support	2	0.5
Processing Architecture	1	0.05
Hardware/OS Support	1	0.1
Communications	1	0.05
Security	1	0.1
Documentation	1	0.1
User Interface	1	0.1
Scheduler	1	0.1
Reporting	1	0.1
Error Handling	1	0.1

Figure 2: Technical Criteria Hierarchy with Weights

Nontechnical Criteria	Hierarchy Level	Weight
Software Costs	1	0.5
Translation Engine	2	0.3
Transaction Sets	2	0.2
Communications	2	0.1
Mapping	2	0.1
Scheduler	2	0.1
Maintenance	2	0.2
Technical Support	1	0.3
Hours of Operation	2	0.2
Quality of Staff	2	0.5
Extra Charges	2	0.3
Vendor Attributes	1	0.2
Market Share	2	0.2
Years in Business	2	0.4
Innovations	2	0.2
Experience	2	0.2

Figure 3: Nontechnical Criteria Hierarchy with Weights

5 Evaluation Procedure

In section 4, a tool was developed to aid in the evaluation of EDI translation software. In this section, a step by step procedure is given as a guide for evaluating several software packages. Such evaluations are typically done as one of the first stages of an EDI implementation project.

In [AEHJ95], the authors provide an overview for the four major steps of an EDI implementation project. They are:

1. The Planning Stage - Where all of the background research into the organizational and technical impact of EDI is conducted.
2. The Acquisition and Development Stage - Where the hardware and software components are chosen based on requirements taken from the planning stage and hardware and software supplier evaluations.
3. The Pilot Stage - Where EDI transactions are carried out with one or two trading partners.
4. The Full Implementation Stage - Where more trading partners are added, usually one at a time.

In the planning stage, technical requirements such as the volume of EDI transactions, the number of potential trading partners and the hardware and operating system platforms to be used are gathered. These requirements should be noted in the context of the evaluation tool presented in section 4.

Once the requirements have been established, the search for EDI translation software can begin. By following the weightings of the criteria, many products can be ruled out right away. For example, if UNIX operating system support is required, all products that can not run under UNIX would be eliminated.

Those EDI translators that meet the most important criteria form a comparison set from which one or two final EDI translators will be chosen. The next step is to obtain demonstration versions or trial versions of the software so that a more in-depth examination of the features can be performed. Most EDI translation software vendors are happy to provide a demo or trial version for this purpose.

Once demo versions have been obtained, scores for all of the criteria at the lowest level of the hierarchy can be obtained. For example, for the nontechnical criteria shown in Figure 3, the following criteria would be considered:

- Costs for the Translation Engine
- Costs for the Transaction Sets
- Costs for the Communications module

- Costs for the Mapping software
- Costs for the Scheduler software
- Costs for the Maintenance agreement
- Technical support Hours of Operation
- The Quality of Staff for Technical support
- Extra charges for Technical Support
- Vendor Market Share
- Number of Years in Business
- Product Innovations
- Experience in various industries

The scores for each EDI translator can be made relative to one another. For example, if the costs for four EDI translator engines are as follows:

EDI Translator A	\$9,000
EDI Translator B	\$4,000
EDI Translator C	\$3,000
EDI Translator D	\$1,000

then EDI Translator D would get the highest score. Scores can generally be done on a range from 1 to 10 so EDI Translator D would receive 10 points, C would receive 9 points, B would receive 8 points and A would receive 7 or fewer points since the cost is much higher.

Once all of the scores for the lowest level of the hierarchy are obtained, each category can be calculated by multiplying the scores by the weight factor and then summing the product. Figure 4 shows the results for rolling up all of the lower level criteria for two different EDI translators (A and B). The scores were computed as follows:

- B's translation engine costs less than A's.
- A gives away all of the transaction sets for a low fee while B charges for each additional transaction set.
- Communications software is built in to A's translation engine so it incurs no extra cost. B's is a separate, but inexpensive add on.
- The mapping software is an additional charge for both A and B but B's is less expensive.

Nontechnical Criteria	Hierarchy Level	Weight	Score A	Score B
Software Costs	1	0.5	8	6.1
Translation Engine	2	0.3	8	9
Transaction Sets	2	0.2	9	5
Communications	2	0.1	10	8
Mapping	2	0.1	5	8
Scheduler	2	0.1	5	8
Maintenance	2	0.2	9	4
Technical Support	1	0.3	8.8	5.8
Hours of Operation	2	0.2	8	9
Quality of Staff	2	0.5	9	5
Extra Charges	2	0.3	9	5
Vendor Attributes	1	0.2	5.8	7.8
Market Share	2	0.2	7	9
Years in Business	2	0.4	3	9
Innovations	2	0.2	10	3
Experience	2	0.2	6	9
<i>Overall Nontechnical Score</i>			<i>7.8</i>	<i>6.35</i>

Figure 4: Nontechnical Criteria Hierarchy with Scores for Two EDI Translators

- The scheduling software is also an additional charge for both A and B but again, B's is less expensive.
- A offers a complete maintenance package for a small additional fee whereas B has a very limited agreement that is very costly.
- As for technical support, both offer similar hours of operation but A's support staff is more knowledgeable about their products and technical support is free for the first year.
- In the Vendor Attributes criteria, B has been in business much longer than A has but they have no new innovations. A is a younger company with very innovative products but suffers from lack of market share and broad, cross-industry experience.

Note that even though one translator dominates in one or two categories, because of the weights, it is possible that the overall score will show the other translator as the better choice. In this example, A has superior technical support but lags behind in the other criteria. Translator B would be the overall better choice when considering just the nontechnical criteria.

As an overview, from the EDI translation software evaluation perspective, the following steps would be followed:

1. Establish a set of criteria for EDI translation software.
2. Weight the criteria in order of importance to the success of the EDI project.
3. Review the features of various EDI software packages eliminating those that do not meet the most important criteria such as operating system support and transaction set support.
4. From the remaining set of EDI translators, obtain demo or trial versions of the software. Install each and fill in the scores for each criteria at the lowest level.
5. Based on the weights, calculate the overall scores for technical and nontechnical criteria.
6. If the overall scores vary considerably, as in the example in Figure 4, then the EDI translation software with the highest score should be considered for purchase in the Acquisition and Development Stage.

When scores are closer together, the decision is less clear. In this case, it is possible that small changes in the weightings can affect which product has the highest score. In such a case, any software package that has a comparable score can be considered for purchase. It is also possible to re-weight the criteria placing more emphasis on criteria where the products differ and place less emphasis on those criteria with similar scores.

6 Conclusions

In this paper, a brief introduction to EDI was given including the major software components required to implement an EDI system. Of these components, the EDI translator is perhaps the most important piece because it embodies and upholds the EDI standards that are crucial for the interchange of electronic business transactions.

There are many EDI translator software packages on the market today. To evaluate these packages, a series of technical and nontechnical criteria were developed and a formal method for using these criteria was introduced. This evaluation procedure can be viewed as an outline for organizing and highlighting the most important criteria for EDI translation software. The CRAMTD project intends to carry this work further by performing evaluations based on these techniques on a number of EDI translators to be used in the manufacturing facility.

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7 Glossary

ACH	Automated Clearing House
AIAG	Automotive Industry Action Group
ANSI	American National Standards Institute
ASC	Accredited Standards Committee
ASCII	American Standard Code for Information Interchange
BBS	Bulletin Board Service
CAD	Computer Aided Design
CAE	Computer Aided Engineering
CAM	Computer Aided Manufacturing
CIM	Computer Integrated Manufacturing
DISA	Data Interchange Standards Association
DLA	Defense Logistics Agency
DoD	Department of Defense
DPSC	Defense Personnel Support Center
EC	Electronic Commerce
EDI	Electronic Data Interchange
EDIA	Electronic Data Interchange Association
EDIFACT	Electronic Data Interchange for Administration, Commerce and Transport
EFTA	European Free Trade Association
EFT	Electronic Funds Transfer
E-Mail	Electronic Mail
ERS	Evaluated Receipt Settlement
FAR	Federal Acquisition Regulation
FIPS	Federal Information Processing Standards
FMS	Financial Management Service
FRB	Federal Reserve Bank
IETF	Internet Engineering Task Force
IGES	Initial Graphics Exchange Specification
IOC	Initial Operational Capability
IOS	Inter-Organizational Information Systems
ISO	International Standards Organization
JIT	Just In Time
MIME	Multipurpose Internet Mail Extensions
MTA	Message Transfer Agent
NII	National Information Infrastructure
NIST	National Institute of Standards and Technology
NTE	Note segment of an EDI message
OLDB	On Line DataBase
PC	Personal Computer
PDE	Product Data Exchange
PDES	Product Data Exchange using STEP
PO	Purchase Order
RDA	Remote Database Access
RFC	Request For Comment
RFP	Request For Proposal
RFQ	Request For Quotation
SBA	Small Business Administration
SF	Standard Form
SGML	Standard Generalized Mark-up Language
SNA	Systems Network Architecture
STEP	Standard for The Exchange of Product Model Data

TDCC	Transportation Data Coordinating Committee
TDED	UNECE Trade Data Elements Directory
TDID	Trade Data Interchange Directory
TEDIS	Trade Electronic Data Interchange Systems
TPA	Trading Partner Agreement
TQM	Total Quality Management
TS	Transaction Set
TSDS	Transaction Set Development System
UN-EDIFACT	International EDI standards committee
UN/ECE	United Nations Economic Commission for Europe
VAN	Value Added Network
VAS	Value Added Service
X12	ANSI ASC sub-committee charged with defining U.S. EDI standards.